CONCRETE
AND
CONSTRUCTIONAL ENGINEERING

NOVEMBER, 1951. **Vol. XLVI, No. 11**

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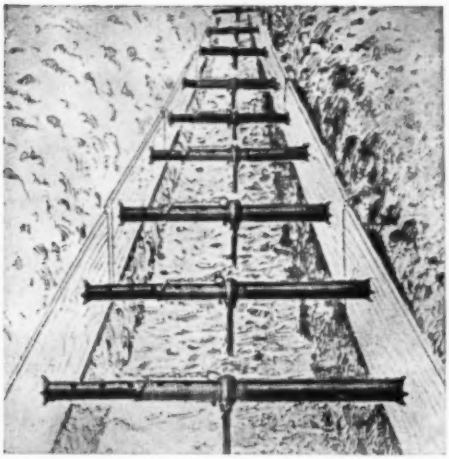

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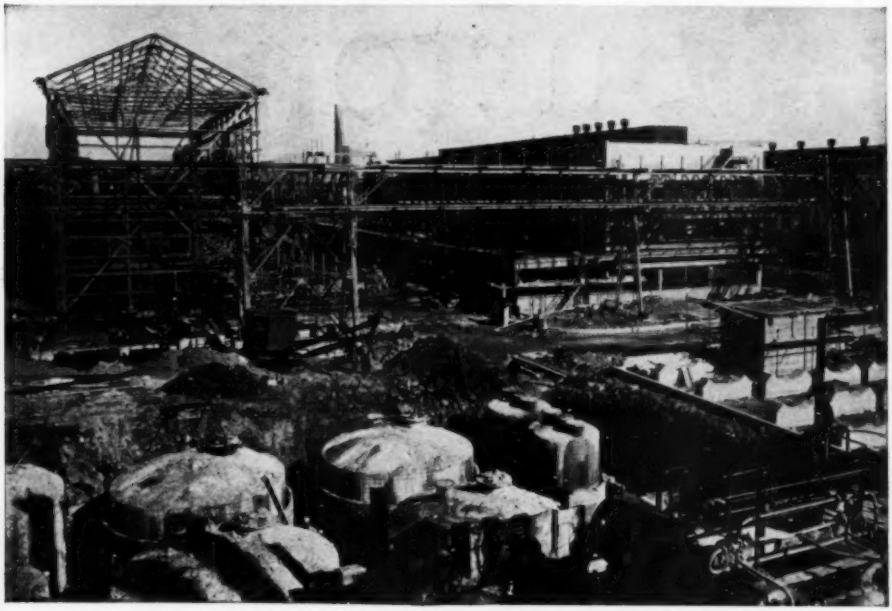

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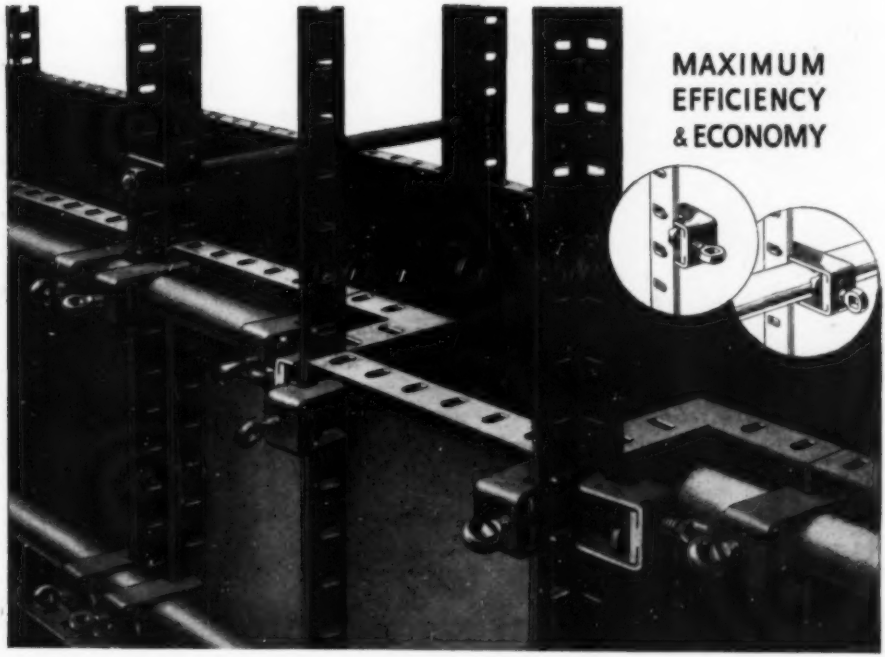

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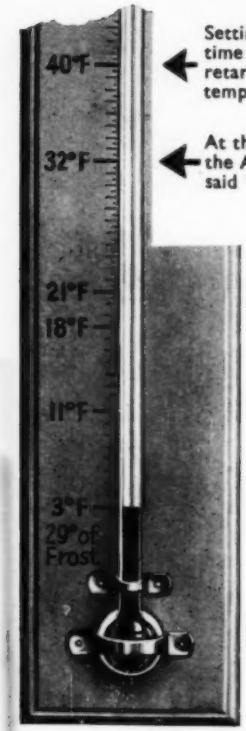

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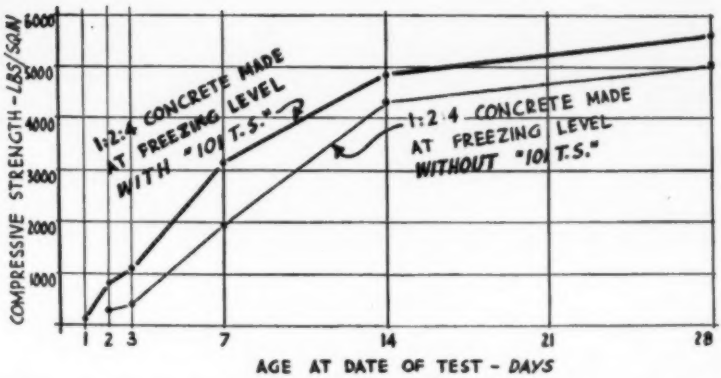

This chart shows the results of tests by R. H. Harry Stanger, Testing Engineer, of Westminster. After only one day, 6" test cubes of 1 : 2 : 4 concrete, made with 101 T.S., show measurable compressive strength. Concrete made without is too weak to be tested at all. For all times of test, 101 T.S. gives a permanent increase of strength over concrete made without. Formwork can be struck and structural concrete can be loaded as in normal weather—progress need not be interrupted.

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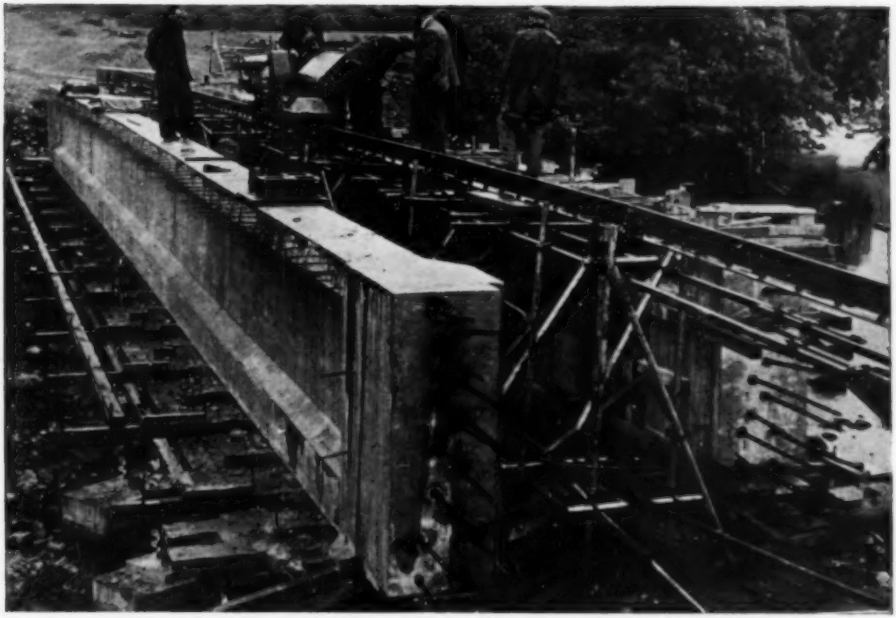

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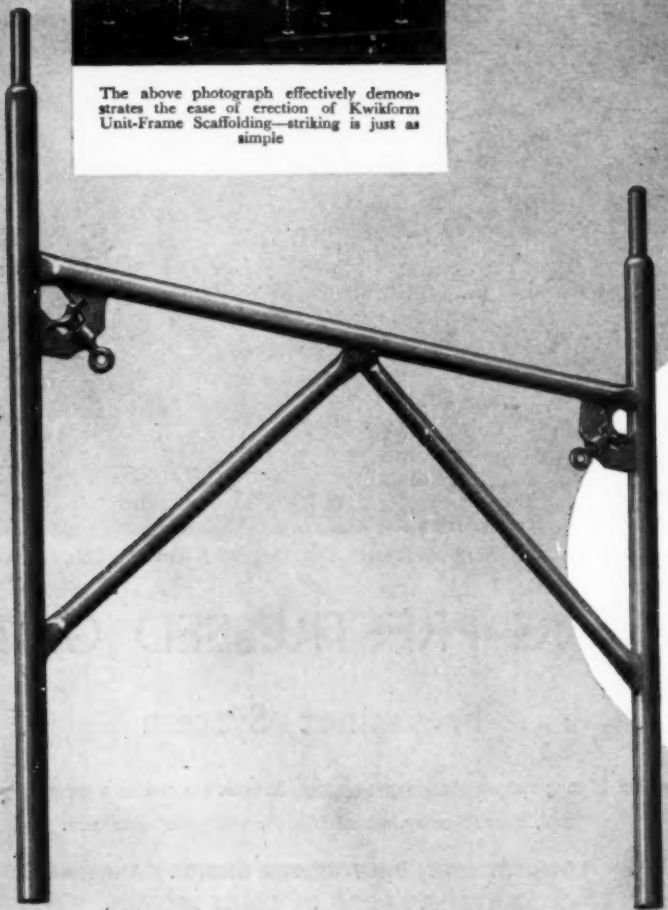

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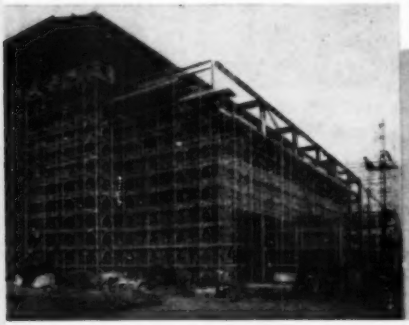

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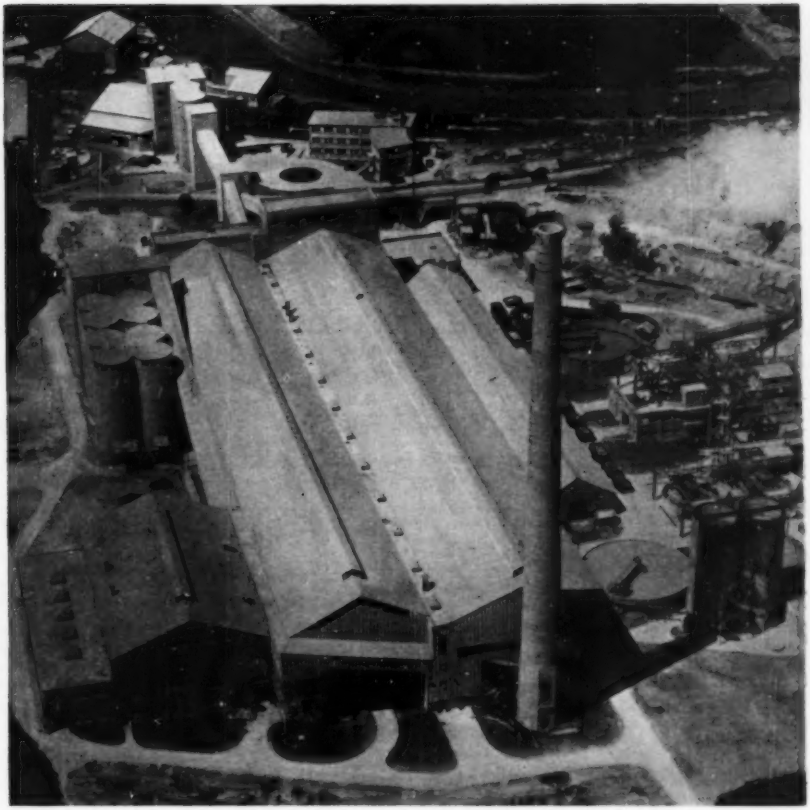

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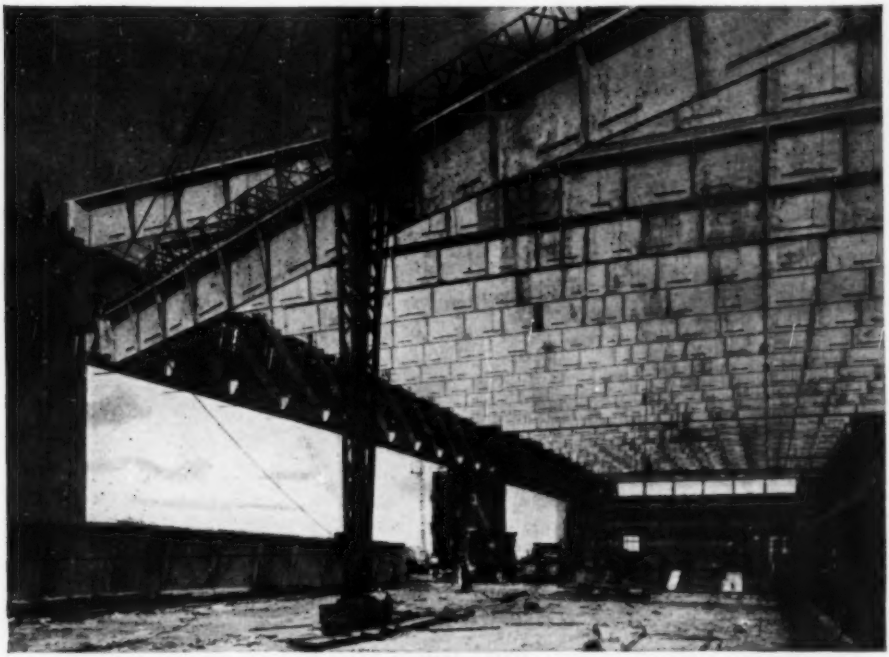

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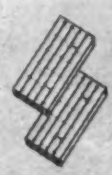

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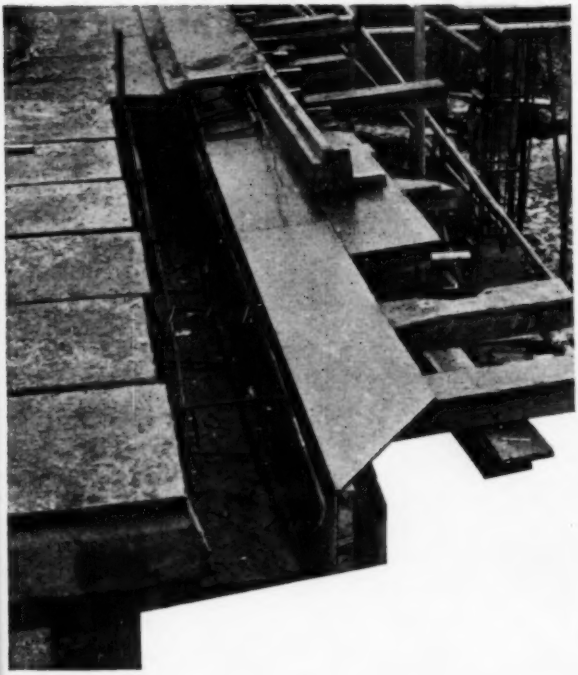

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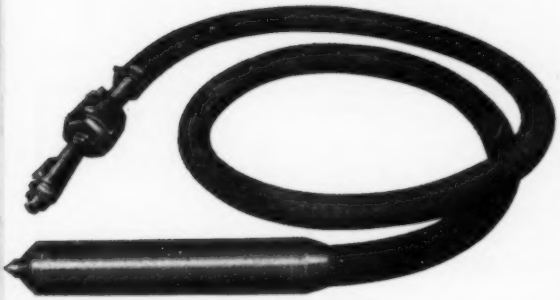

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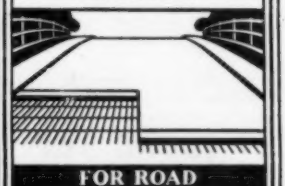
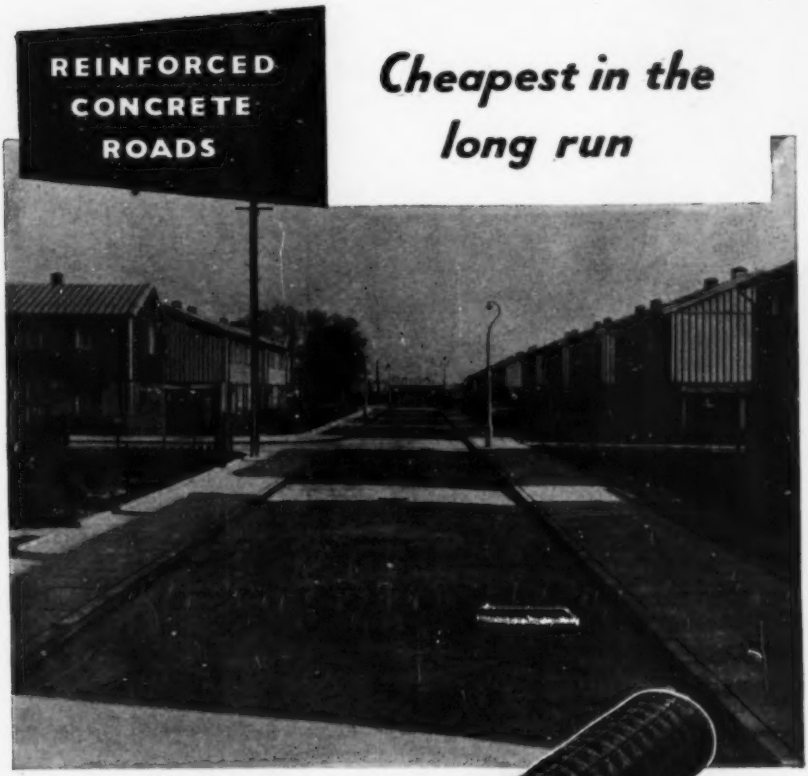


FOR ROAD REINFORCEMENT



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WITH REINFORCEMENT

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WITHIN THE ROAD'S STRUCTURE

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FOR ALL SIZES OF
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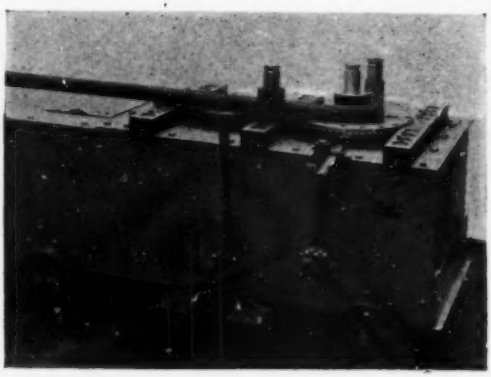

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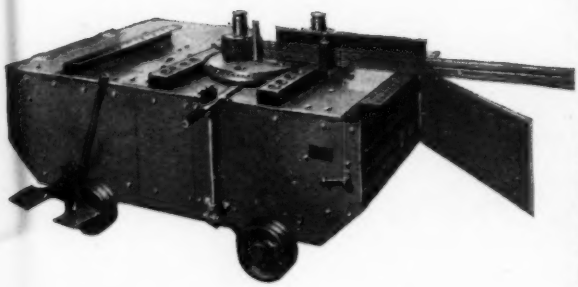

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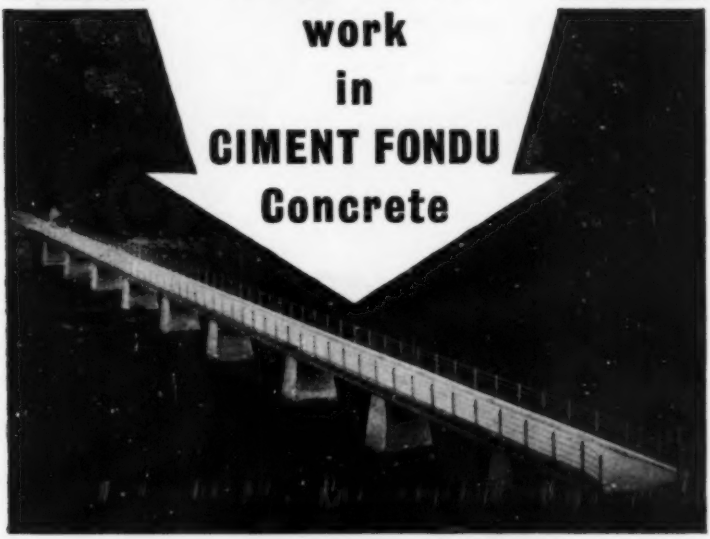

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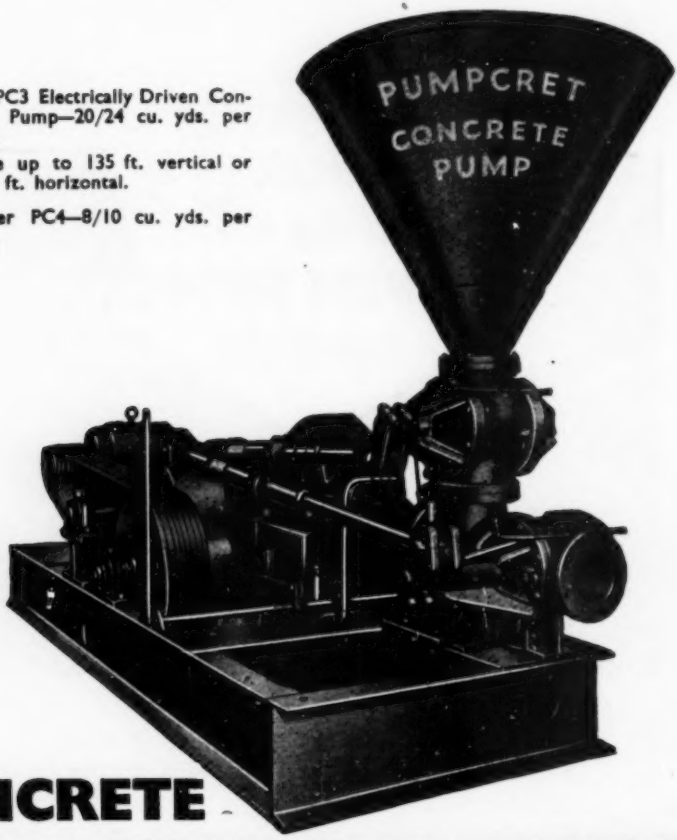

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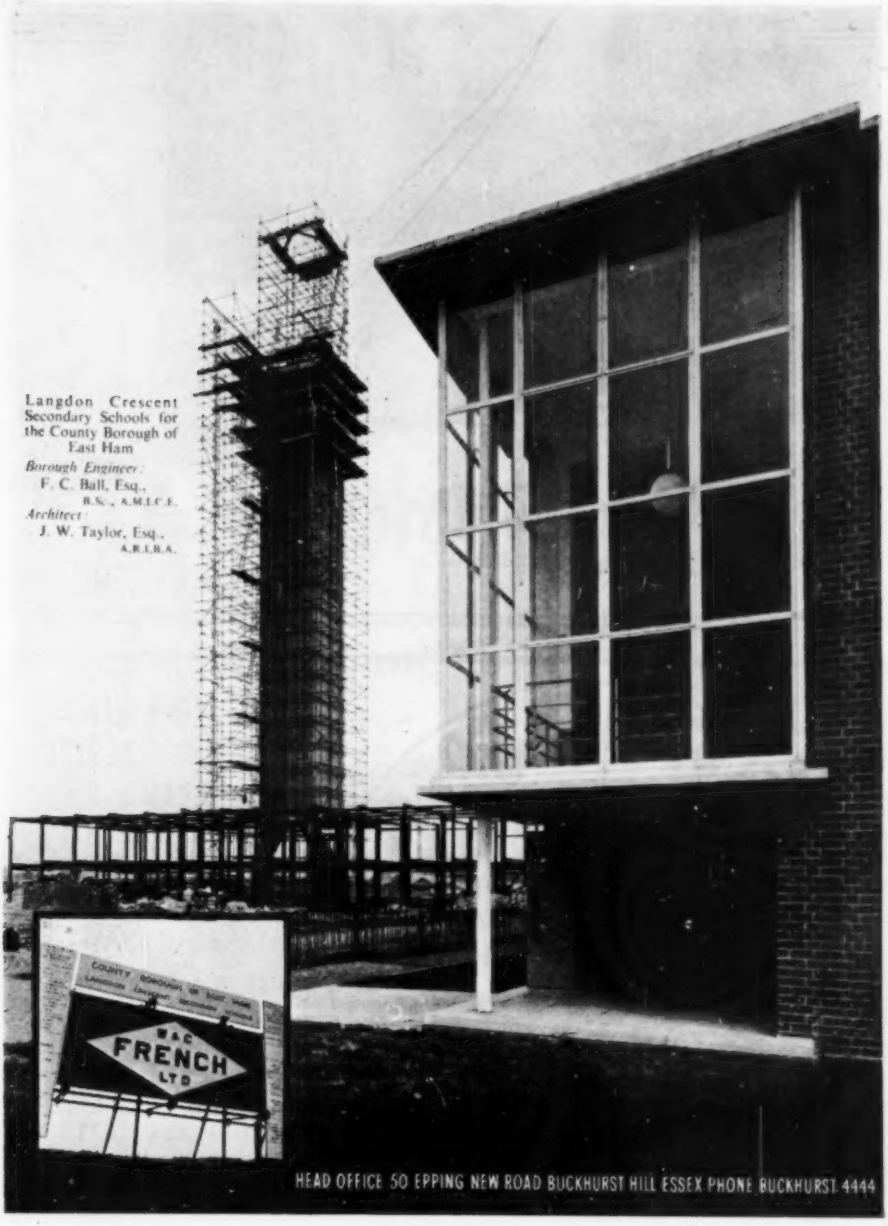
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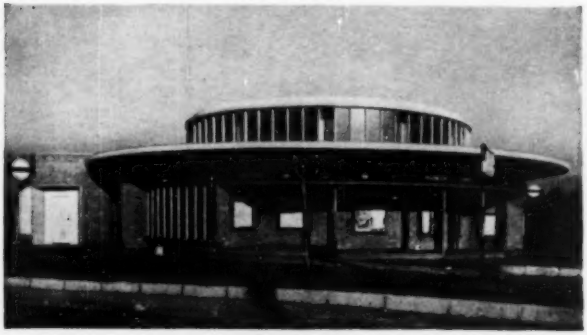

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★ *There was so little to choose between the entries received from Mr. Guy and Mr. Kirby that the Judging Panel considered it would be unfair to award the £500 prize. A special prize of £250 is therefore being awarded to Mr. Guy and the balance of £250 is being donated to the London Association of Builders' Foremen and Clerks of Works, in accordance with the terms of the Competition.*

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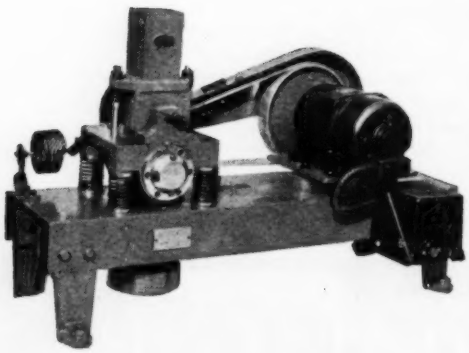

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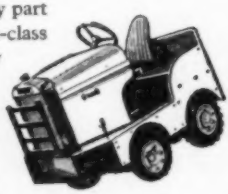

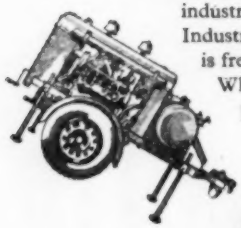

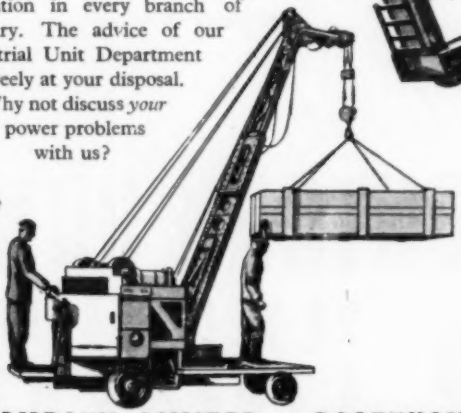

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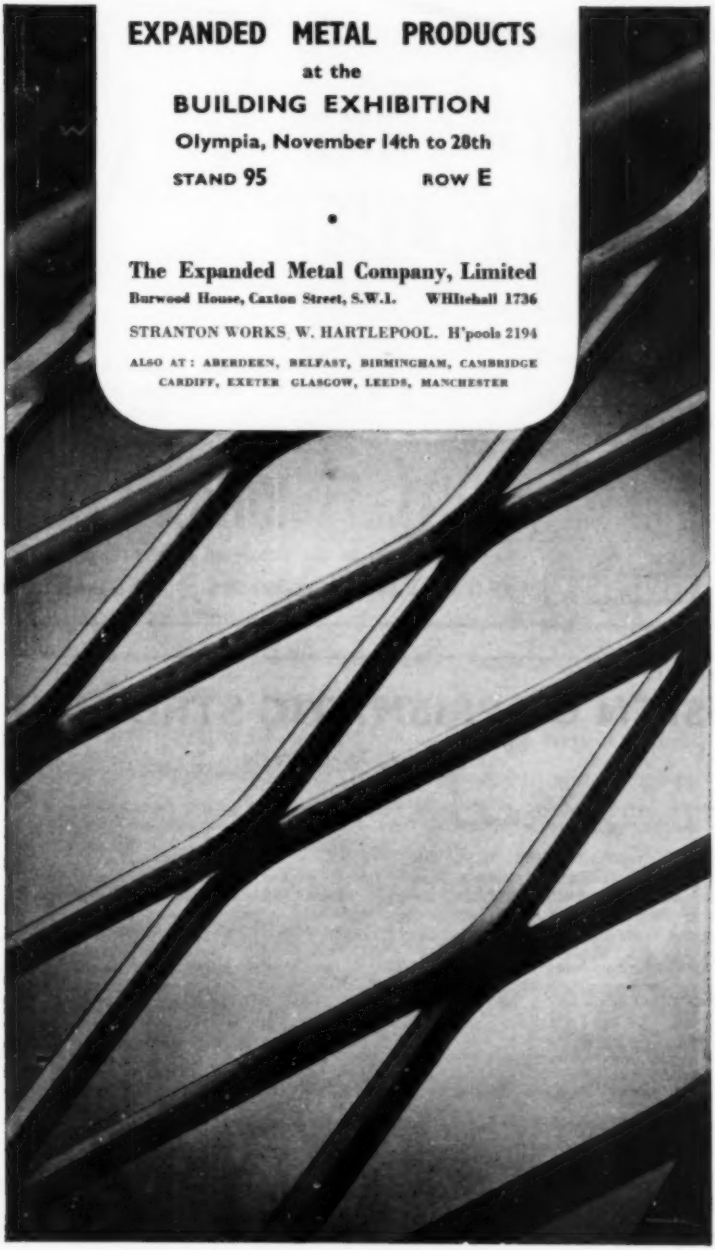
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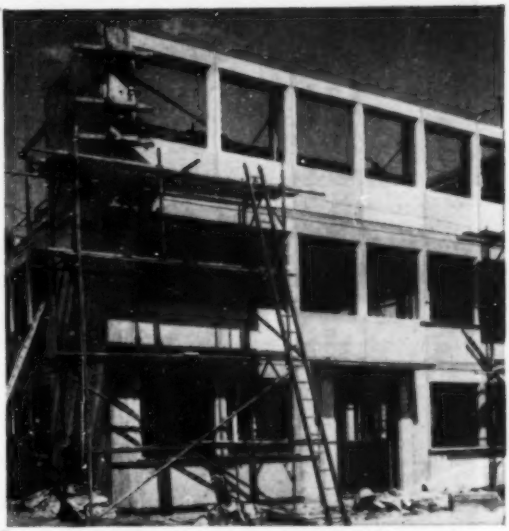

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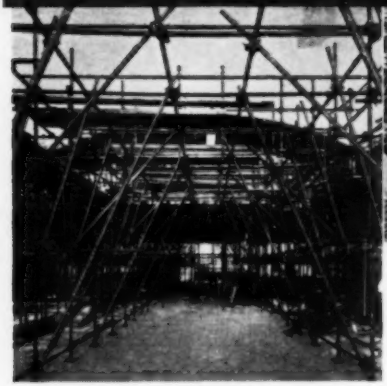

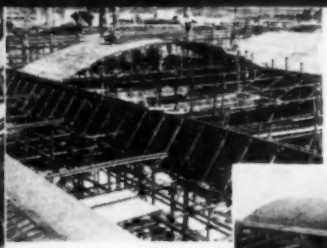

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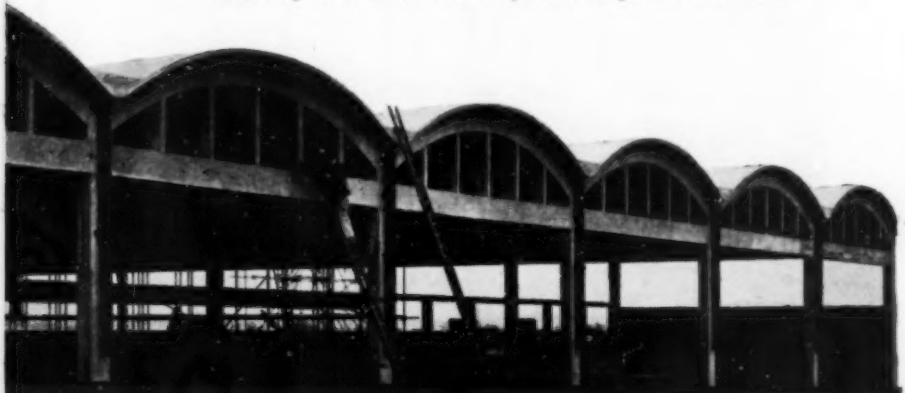

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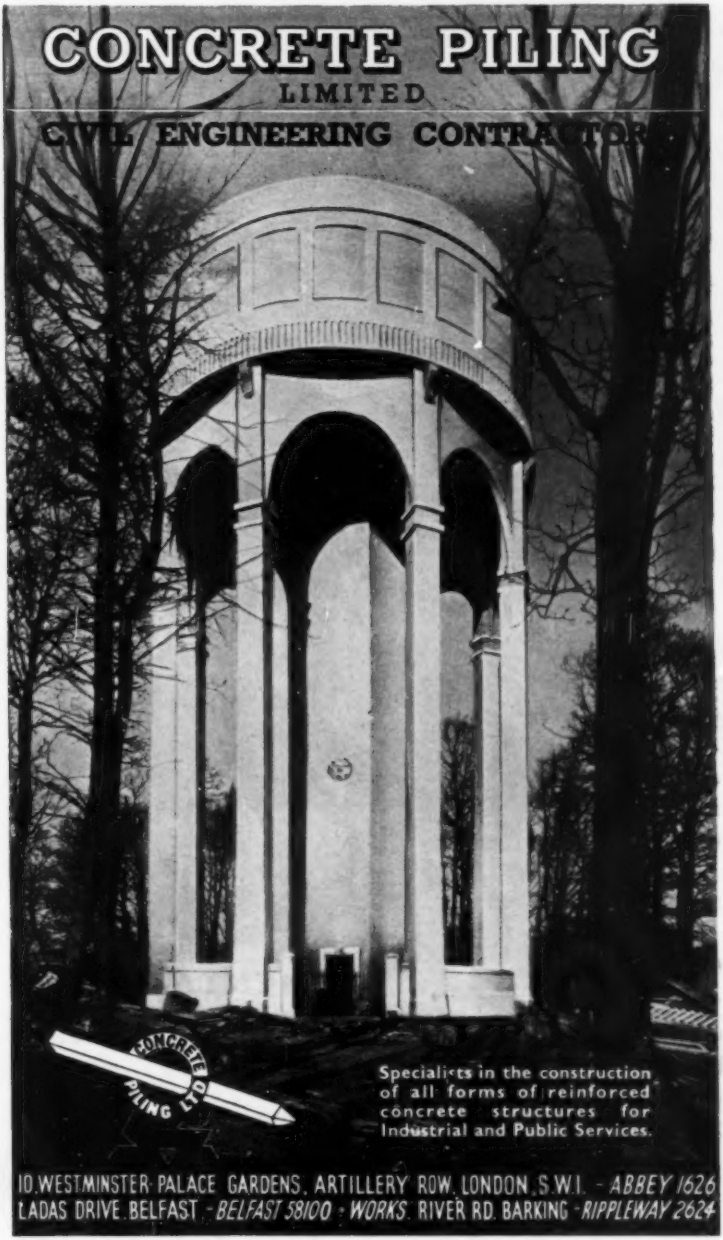
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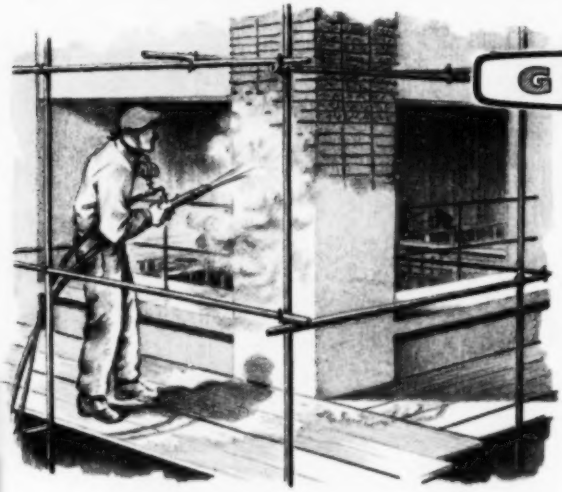

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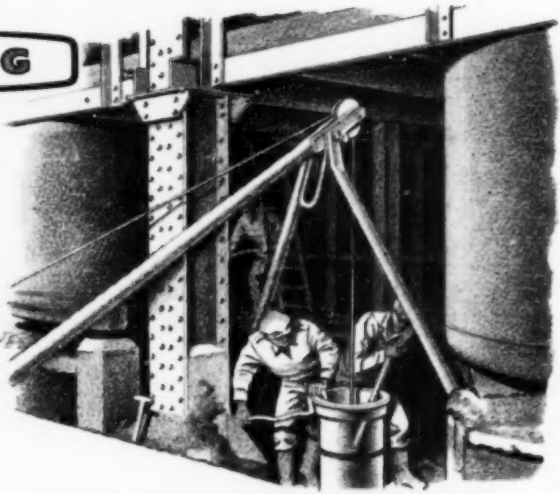

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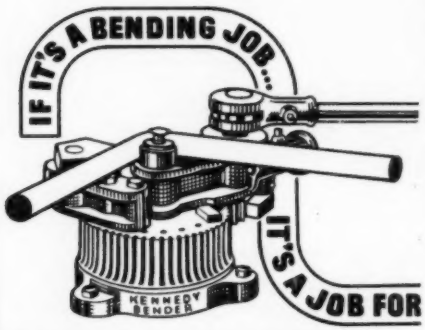

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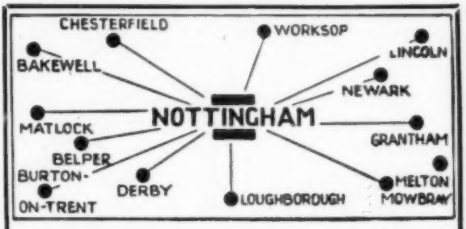

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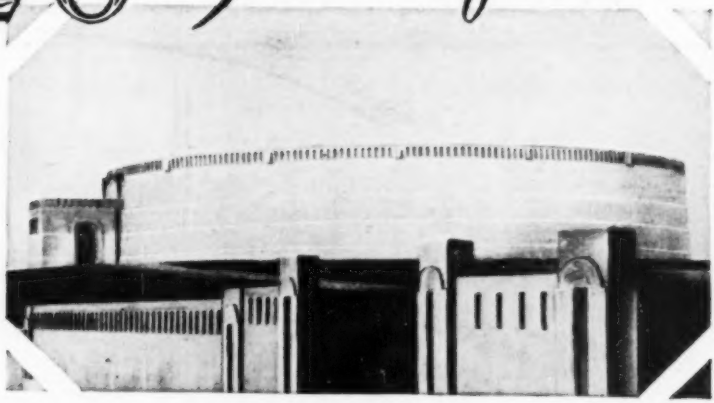

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Volume XLVI. No. 11. LONDON, NOVEMBER, 1951.

EDITORIAL NOTES

Views on Prestressed Concrete.

IN the month of September last, much was said and published on prestressed concrete. There was a congress on prestressed concrete in Belgium and a symposium in London, papers on prestressed concrete were read at a congress on building in London, and a report of the Institution of Structural Engineers on this subject was published.

The need for more research was emphasised in most of the papers read at the congress in Belgium, and two of the resolutions were that special attention should be given to research on the elastic, plastic, and viscous deformation of concrete, on the effect of repeated and alternating loading, on the effect of variations of temperature and humidity, on the deformation of concrete subjected to shearing, and on the cracking of slabs prestressed in two directions. The best laboratory is often the site, and an organisation in Belgium is doing valuable service by publishing information on the defects it has observed in its investigations of prestressed concrete structures in course of construction, and in making proposals for avoiding defects. Much laboratory research is being done in Great Britain, as is shown in a survey given at the London building congress. The resistance of prestressed concrete to fire is one of the more important subjects needing investigation. Tests in this country have shown that prestressed concrete floors with siliceous aggregate are more resistant to fire if the underside is covered with plaster than if a greater thickness of concrete is not so protected.

It seems that some recent structures built in prestressed concrete are less costly than if built in other materials, although little information on this subject is readily available. In one paper at the Belgian congress data are given to show that the cost in Great Britain of a small prestressed concrete bridge is about 70 per cent. of the cost of a reinforced concrete bridge. The principal reasons given are savings in abutments and centering. The working stresses adopted in these low-cost prestressed concrete bridges are, however, high, and it may be that, if the working stresses in reinforced concrete beam structures were as great, the reinforced concrete structures could be built at about the same cost. This possibility is supported by reports from the Continent which show that reinforced concrete bridges designed for very high stresses are proving cheaper.

Statically-indeterminate structures were the subject of the symposium in London and of several papers at the Belgian congress. The proposals of different engineers appear to fall into two classes, namely, those in which a shape for

the undulations of the cable is assumed, and those in which the shape is decided after consideration of the bending moments. The history of statically-indeterminate prestressed concrete structures has followed the course of so much engineering in that practice has preceded the development of theory. As a speaker said at the symposium, when practice has shown the way, sound theories enable refinements to be made and confidence gained. The chief problem is to determine the reactions, and therefore the deformations and stresses caused by prestressing, and the designer must decide, for a particular structure, which theory he should use, or whether he should sacrifice a little economy and be more sure of the applicability of his calculations by providing straight cables in a member of constant depth. If the cables are not straight there arises the problem of how much of the prestressing force is lost by friction at the bends. Available information differs widely, as might be expected when the surface of the cable and the duct in which it is placed and the radii and number of bends vary considerably. Reports of conditions in actual structures vary from so little friction that the cable can be pulled through the duct by hand to measured reductions of half the prestressing force. Research on this subject is proceeding.

The report of the Institution of Structural Engineers * is an interesting document, admittedly of an interim nature and not dogmatic. A feature of the report is an attempt to compromise between contrary opinions on design. The opposing views that design should be based on working conditions or on conditions at failure are reconciled by recommending that both conditions should be considered in all designs. On the other hand, the report is in favour of some important structures being designed so that at working load tensile stresses occur in the concrete, although some leading exponents of prestressed concrete firmly hold the contrary view. Even in structures in which cracking at working loads must be avoided the report agrees that a tensile stress equal to half the modulus of rupture is permissible, even if the structure be subject to fatigue. There appears to be little margin in this recommendation for accidental overload. If the structure be subjected to impact, the report quite properly suggests that tensile stress at working load is not permissible. The recommendations for estimating the amount by which the prestressing force is reduced in course of time appear to be based on the principles of " limit design," and it is recommended that either the maximum or minimum reductions be considered in different parts of the calculations instead of the same reduction throughout.

We have previously expressed the view that the time has not yet come when a standard specification for prestressed concrete is desirable, and it is interesting to note that another resolution of the Belgian congress was to the effect that any tentative regulations for prestressed concrete should allow waivers to be granted where these are considered to be justified, so that progress will not be hindered. This congress also agreed that an international notation for prestressed concrete should be prepared; it is hoped that organisations that have hastily issued recommended national notations will co-operate in this desirable object. The question of an agreed name to replace terms such as prestressed and elastic concrete might also be usefully discussed; " compressed concrete " is probably the most accurate description.

* " First Report on Prestressed Concrete." London: Institution of Structural Engineers. Price 3*s.* 6*d.*

Reinforced Concrete Slurry Tanks.

BY OSCAR FABER, C.B.E., D.Sc., M.Inst.C.E.

In an article in the September, 1951, number of this journal on the new cement works at Shoreham for the British Portland Cement Manufacturers, Ltd., reference was made to the reinforced concrete tanks which form part of the works, and some further notes on those structures may be of interest.

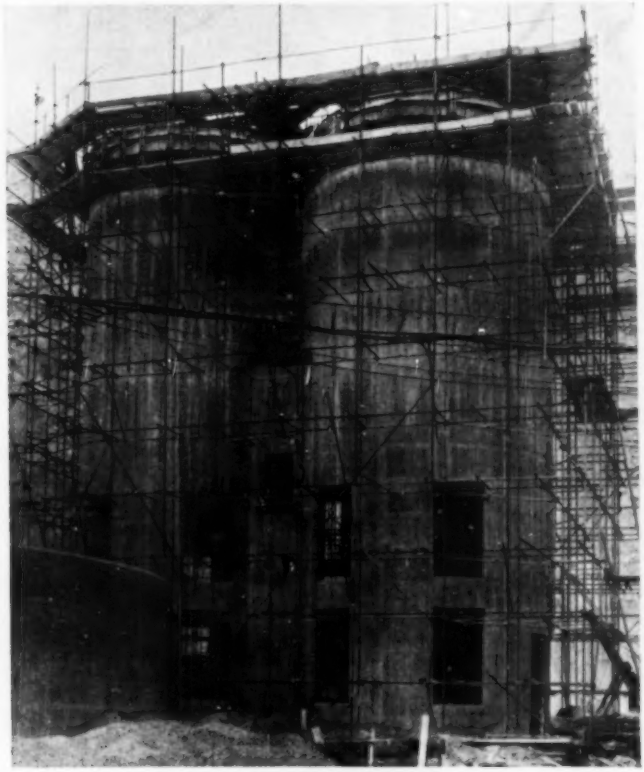

Fig. 1.—Final Mixing Tanks.

Chalk slurry is made in the washmills and clay slurry is added thereto, and this mixture is pumped to preliminary mixers where air agitation gives a more uniform product. The mixture next passes to the final mixers, where further air agitation is given before it is pumped to storage tanks. In these tanks the slurry is continuously stirred and aerated to maintain it in a uniform state prior to being burnt in the kilns.

The accompanying illustrations show the tanks in various stages of construction and the drawings show the arrangement of the reinforcement. *Figs.* 1

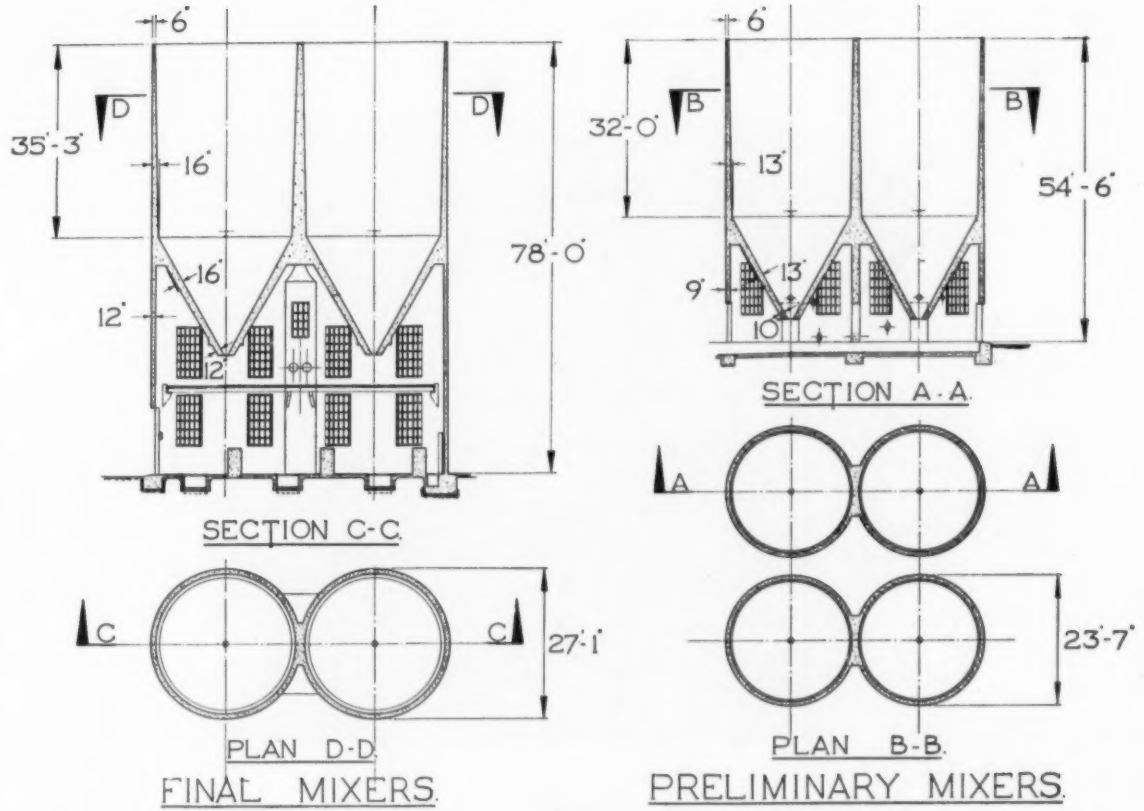
6'
D
D
35'-3"
16'
16'
12'
12'
78'-0"
SECTION C-C.
C
C
27'-1"
PLAN D-D.
FINAL MIXERS.
6'
B
B
32'-0"
13'
54'-6"
9'
13'
10'
SECTION A-A.
A
A
23'-7"
PLAN B-B.
PRELIMINARY MIXERS.

Fig. 2.

to 7 are of the final and preliminary mixing tanks, and *Figs.* 8 to 10 are of the slurry storage tanks. The preliminary mixers are 54 ft. 6 in. high with an outside diameter of 23 ft. 7 in. There are four such tanks constructed in two pairs, the tanks forming each pair being in contact for their full height. There are two final mixers built together to form a pair, and these are 78 ft. high with an outside diameter of 27 ft. 1 in. The storage tanks, of which there are three for

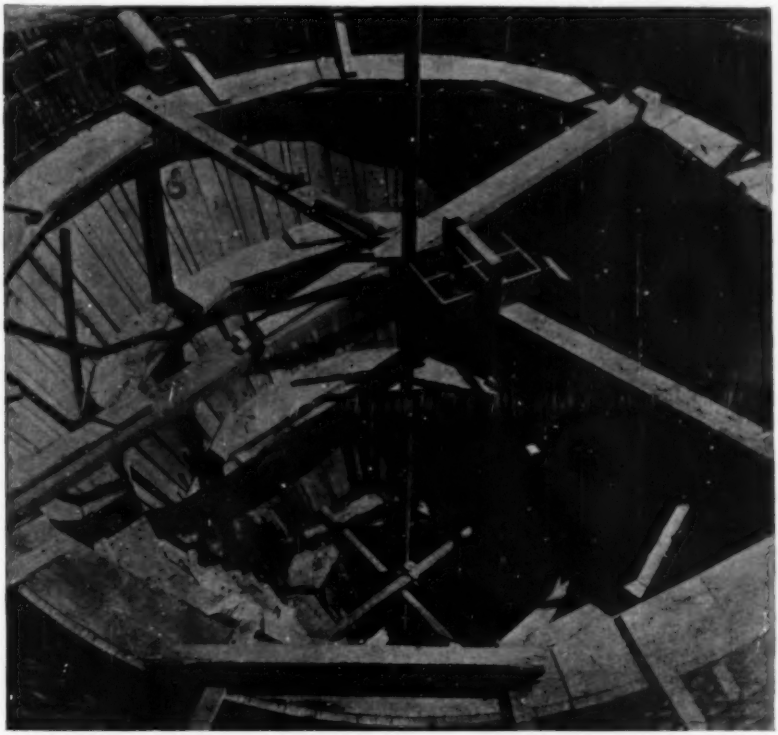

Fig. 3.—Shuttering for two Lifts of Concrete in Conical Hoppers of Preliminary Mixers.

finished slurry and one for clay, are all 66 ft. in diameter measured to the centre line of the walls and have an overall height of 14 ft. 8 in.

Design.

If tanks such as these leak, large and ugly damp patches, efflorescence, and growths may appear, and the reinforcement may be corroded. With this in mind all reasonable precautions were taken in the design and construction to make the tanks really watertight. The design is based on the "Code of Practice for the Design and Construction of Reinforced Concrete Structures for the Storage of Liquids" prepared by a committee of the Institution of Civil Engineers, except

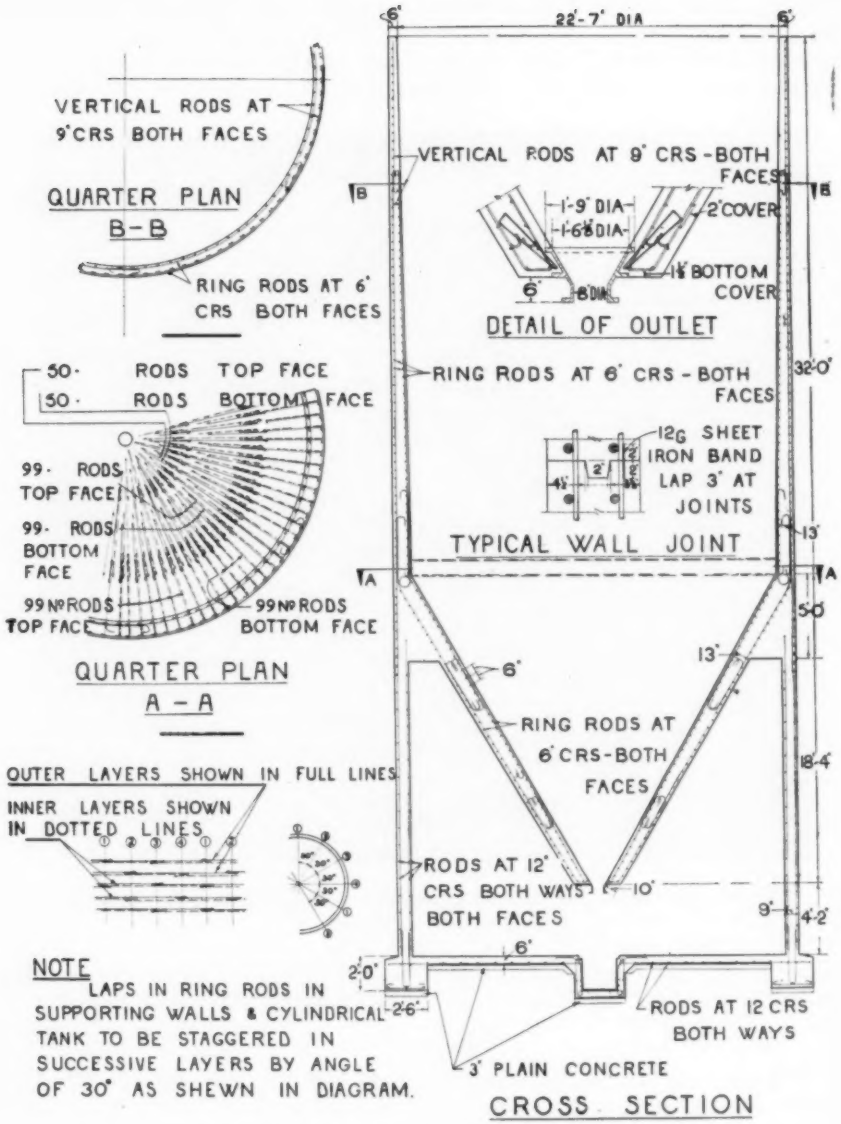

Fig. 4.—Details of Preliminary Mixing Tanks.

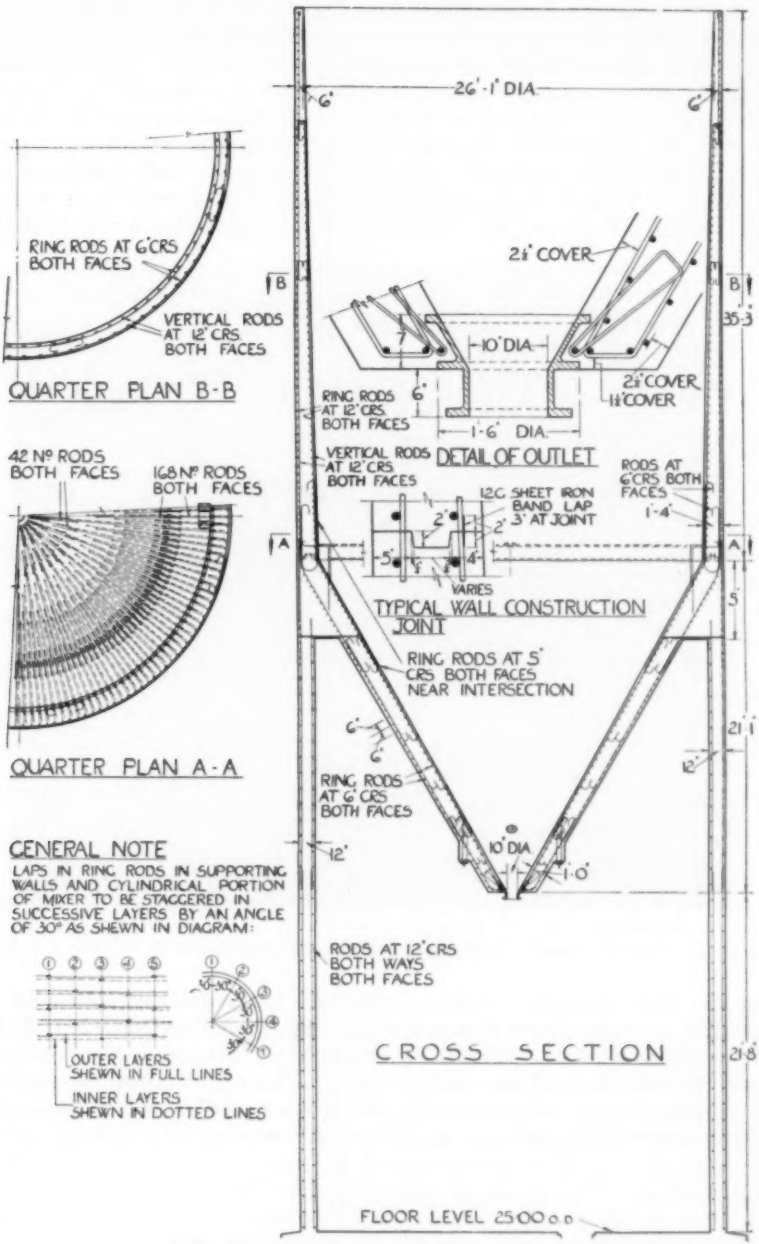
RING RODS AT 6" CRS BOTH FACES
VERTICAL RODS AT 12" CRS BOTH FACES
QUARTER PLAN B-B
42 Nº RODS BOTH FACES
168 Nº RODS BOTH FACES
QUARTER PLAN A-A
GENERAL NOTE
LAPS IN RING RODS IN SUPPORTING WALLS AND CYLINDRICAL PORTION OF MIXER TO BE STAGGERED IN SUCCESSIVE LAYERS BY AN ANGLE OF 30° AS SHEWN IN DIAGRAM:
OUTER LAYERS SHEWN IN FULL LINES
INNER LAYERS SHEWN IN DOTTED LINES
26'-1" DIA
2½" COVER
10" DIA
2½" COVER
1½" COVER
RING RODS AT 12" CRS BOTH FACES
1'-6" DIA
VERTICAL RODS AT 12" CRS BOTH FACES
DETAIL OF OUTLET
RODS AT 6" CRS BOTH FACES
12G SHEET IRON BAND LAP 3" AT JOINT
VARIES
TYPICAL WALL CONSTRUCTION JOINT
RING RODS AT 5" CRS BOTH FACES NEAR INTERSECTION
RING RODS AT 6" CRS BOTH FACES
10" DIA
RODS AT 12" CRS BOTH WAYS BOTH FACES
CROSS SECTION
FLOOR LEVEL 25'00
35'-3
21'-1"
21'-8"

Fig. 5.—Details of Final Mixing Tanks.

that the requirement of the code that the thickness of the concrete should not be less than 1 in. in excess of one-fortieth of the depth below the level of the liquid has not been adhered to in the conical hoppers. In the case of the preliminary and final mixers this requirement would have resulted in the concrete cones being about 16 in. thick. They are in fact 10 in. thick, and have proved quite satisfactory. The walls and bottoms of these tall tanks vary in thickness approximately in accordance with the hoop tension, to comply with the anti-cracking requirement. It might be thought that chalk-clay slurry would tend to seal any cracks should they occur, but observation of actual structures shows that this

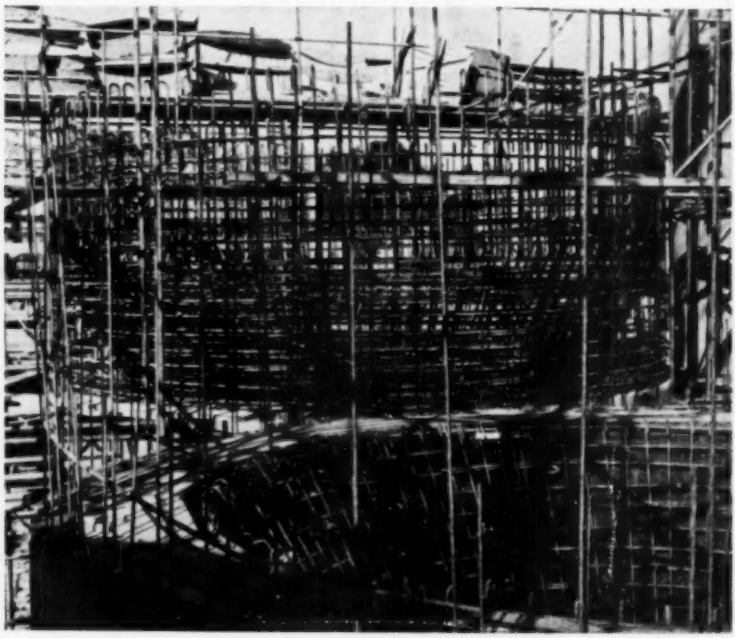

Fig. 6.—Reinforcement in Hopper Bottoms of Preliminary Mixing Tanks.

is not so. The tanks were therefore designed to resist cracking as well as to be of adequate strength should they crack. In complying with the Code of Practice requirement for resistance to cracking, it was found to be logical and economical to vary the thickness of the walls of the preliminary and final mixing tanks, making them thinner where the hoop tension is low and thicker where the hoop tension is high. Thus the walls are 6 in. thick at the top and uniformly increase to 16 in. at the bottom of the cylinders in the final mixers, and 13 in. in the preliminary mixers. This variation ensures that the tensile stress in the concrete is less than 175 lb. per square inch. It is of interest to note that these slurries weigh considerably more than water, the clay slurry weighing 76 lb. per cubic foot and the chalk-clay slurry 100 lb. per cubic foot.

Construction Joints.

Leaks are most likely to occur at bolt holes and construction joints, and it is therefore desirable that these should be as few as possible and that special precautions should be taken at these points. No vertical joints were permitted in the walls, and concrete was placed at a rate such that, using two gangs if necessary starting opposite each other on the perimeter, by the time the concrete last placed reached the concrete placed first in any lift the concrete first placed had not appreciably stiffened. Horizontal construction joints were rebated, and vertical water-bars consisting of galvanised steel strips 4 in. wide were cast in

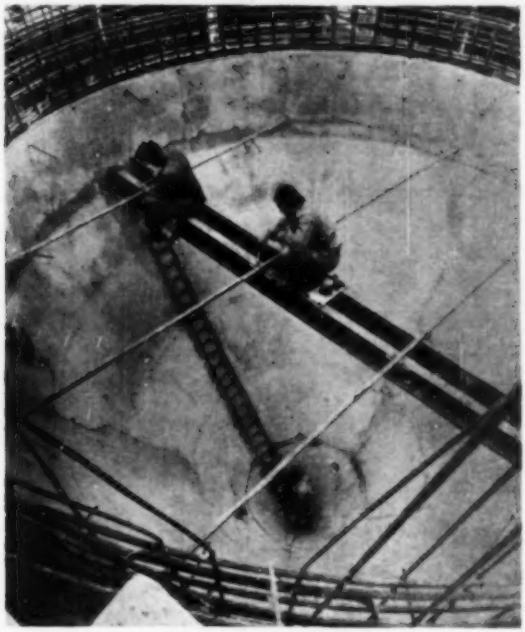

Fig. 7.—Preliminary Mixers. Concreting of Cone completed. Preparing Scaffolding for higher work.

to a depth of 2 in. in the lower concrete, the other 2 in. being left projecting to bond in the next lift of concrete. Before placing fresh concrete against the previous lift, the construction joints were thoroughly cleaned by hacking and brushing with a wire brush. This treatment provided a suitable rough surface which was then watered and coated with a $\frac{1}{2}$-in. layer of 2 : 1 sand-cement mortar mixed to a consistency such that it would only just flow when encouraged to do so with a punning rod.

Concreting.

The concrete was in the proportions of 4 cu. ft. of shingle graded from $\frac{3}{4}$ in. to $\frac{3}{16}$ in., 2 cu. ft. of graded sand, and 112 lb. of ordinary Portland cement. Water

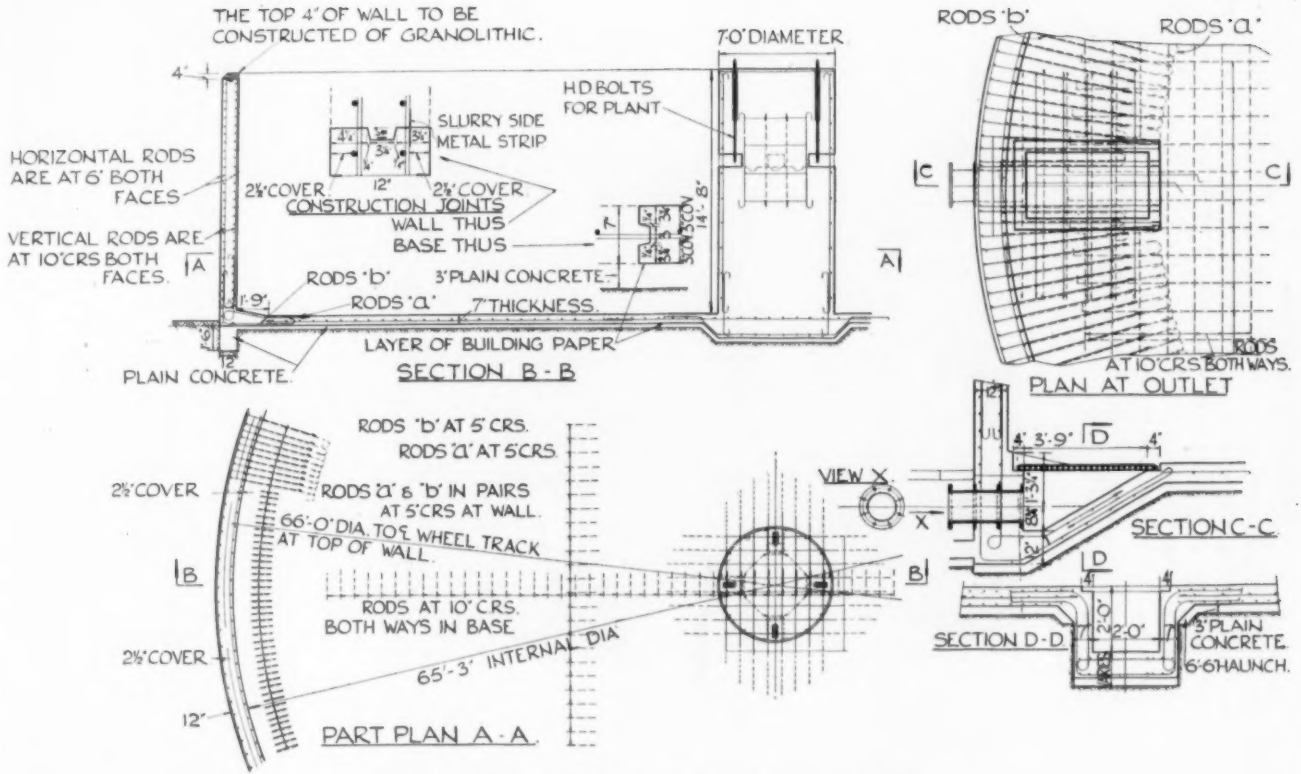

Fig. 8.—Details of Chalk-Clay Slurry Storage Tanks.

was added to give a slump of between 2 in. and 4 in. ; the concrete was too stiff for consolidation by hand punning, and immersion vibrators were used. These vibrators are liable to cause segregation with a slump of about 4 in. if they are left in one position too long, and care was taken to ensure that the vibrators were moved often enough to avoid trouble from this cause. Vibration alone is not

Fig. 9.—Clay-Slurry Storage Tank during Construction.

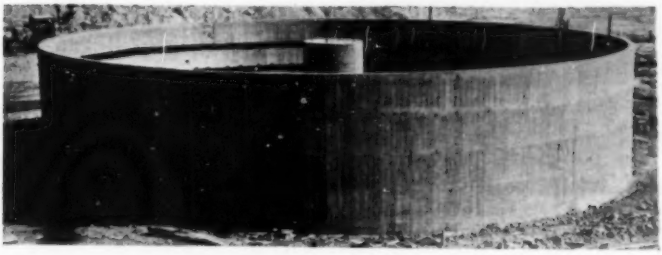

Fig. 10.—Clay-Slurry Storage Tank.

completely satisfactory adjacent to concrete already hardened, and at the construction joints careful punning and vibration were used to ensure that no air pockets were left and that the adhesion was as efficient as possible.

Surface Finish.

A good surface finish to the concrete was desired, and to achieve this the vertical shutters were removed while the concrete was still green and the surface was then wetted and rubbed with wooden floats to ensure that air pockets or other small blemishes were filled with mortar rubbed from the green concrete, and this helped to maintain a uniform colour. The use of mortar for rubbing the surface was not allowed. On completion, the whole of the surfaces of the tanks which would be exposed were rubbed with carborundum blocks or grinding wheels to a smooth and even finish. This resulted in a texture and appearance resembling a smooth stone surface. In some cases, for example, horizontal surfaces and elsewhere where it was impossible to strip the shuttering from the concrete while it was in a green state, great care was taken to obtain smooth shuttering. After stripping, these surfaces were ground with a carborundum block or grinding wheel.

Curing.

If concrete is allowed to dry out too quickly, even under the influence of an English sun, shrinkage cracks are very likely to be formed. Therefore, as soon as the shutters were removed and the concrete rubbed down, the surface was kept moist with continuously-wetted hessian, or with sprays where hessian could not be used. As soon as the concrete was hard enough, water was stored inside the tanks to prolong the period of maturing as much as possible. This was especially helpful in the case of the 66-ft. diameter slurry tanks, the flat bottoms of which could be covered with water very shortly after they were cast.

During cold weather the aggregates and mixing water were heated so that the temperature of the concrete was about 70 deg. F. during placing, and cover provided to give protection during the early stages of setting and hardening.

The internal faces of construction joints were painted with a bitumen-base paint as soon as the concrete was hard enough to permit this to be done. On completion, the tanks were filled with water and left filled for some weeks, so that it could be observed whether or not they were thoroughly watertight. They were then emptied and the whole of the inside surface of the walls and conical outlets or bottoms was painted with bitumen-base paint. They were then re-filled with water and left until required for use.

Foundations.

All these tanks are founded on chalk, so that very little trouble was encountered with the foundations. In the case of the 66-ft. diameter flat-bottom storage tanks, the ground was levelled and covered with a mat of plain concrete 3 in. thick, trowelled to as smooth a surface as possible. This concrete was covered with building paper and the reinforced concrete bottoms of the tanks cast on top. The object of the plain concrete mat was twofold. First, it protected the newly-excavated chalk from deterioration by wet or frost and provided a clean base on which the building paper and reinforcement could be laid, and secondly it allowed a limited movement of the tank during filling and reduced the risk of cracking.

Messrs. Oscar Faber & Partners, the consulting engineers for The Associated Portland Cement Manufacturers, Ltd., designed the tanks and supervised their construction. The main contractors for the new works, of which these tanks form a part, were Messrs. John Laing & Son, Ltd., and Messrs. Bierrum & Partners, Ltd., constructed some of these tanks as sub-contractors.

British Standard Code for Dense Concrete Walls.

A BRITISH Standard code for "Dense Concrete Walls" (No. 123.101, 1951; price 4*s*. from the British Standards Institution) deals with the construction of solid and cavity walls of plain and reinforced dense cast-in-situ concrete. Recommendations are made regarding materials, proportioning and mixing of the concrete, the control of shrinkage, expansion joints, surface finishes, damp-proof courses, and construction including setting out, scaffolding, and shuttering. Illustrations of expansion joints and methods of damp-proofing various types of walls, openings, roofs, and chimney stacks are given. Tables of thermal transmittance coefficients for solid and cavity walls with various linings and finishes are given, as are average values of sound reduction for different thicknesses of wall. Structural design is not dealt with, reference being made for this purpose to British Standard Codes of Practice Nos. 111 and 114.

Construction of a Dock in Cheshire.

A NOVEL CLIMBING SHUTTERING.

THE new dock in course of construction at Eastham, where the Manchester Ship Canal joins the river Mersey, is 900 ft. square and access is through a lock having an overall length of 807 ft. and a width of 100 ft. Outside the lock there is a leading wall 730 ft. long, and there are three cambers or recesses in the wall on one side of the lock to take the sliding steel gates. The dock, the depth of water in which will be 40 ft., is intended for the use of oil tankers of 30,000 tons, the oil being pumped to the new Stanlow refinery through a pipe-line seven miles long. The dock, lock, and cambers have mass concrete gravity walls, which are 52 ft. 6 in. high in the dock and 58 ft. 8 in. high in the lock. The shuttering for the walls (*Figs.* 1 and 2) is a novel form of climbing shuttering as described later. The floor of the lock (*Fig.* 3) is also of plain concrete and is generally 4 ft. thick at the centre and 6 ft. thick at the sides.

Excavation.

Extensive cofferdams are required to enable construction to proceed in the dry, and include a rock-fill dam with a steel sheet-pile cut-off wall 1700 ft. long. The dam is 30 ft. deep, 100 ft. wide at the bottom, and 18 ft. wide at the top. There are about 3,500,000 cu. yd. of excavation, about half of which is in soft soil and the remainder in sandstone requiring blasting. Excavating proceeds day and night and the soil is transported to deposit grounds by 36-in. and 42-in. band conveyors the total length of which is two miles, the longest length of one conveyor being 1400 ft. Drag-line excavators deposit the spoil into steel hoppers which feed on to the conveyors, at the discharge end of which are radial spreaders. The conveyors travel at a speed of 280 ft. per minute and can dispose of 600 tons of spoil per hour.

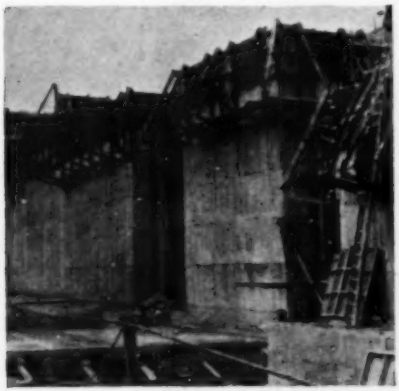

Fig. 1.—Leading Wall in Course of Construction.

Fig. 2.—Construction of one of the Lock-gate Cambers.

Shuttering.

The shuttering for the main walls (*Figs.* 1 and 4) and the sides of culverts (*Fig.* 5) comprises triangular steel soldiers and plywood panels, both of which are rotatable and are of a design patented by the contractors. Each soldier, which is an isosceles triangle in shape, is made of five double-channel 4-ft. links (Nos. 1 to 5 in *Fig.* 6) each of which has a hinged con-

nection with adjoining links. At the bottom of a wall concrete is placed to a depth of 4 ft. behind ordinary shuttering, a bolt being embedded near the top of the lift. For the next lift the soldiers are placed so that the bolt projects through link (4) and is secured to it by a plate, link (4) being against the hardened concrete. The shape of the soldier is maintained by the tie-rods T1 and T2, adjustment of the length of which by turnbuckles keeps link (5) in its proper position. Link (5) is fixed to lean slightly inwards so that small outward movement under pressure of the wet concrete results in it being vertical. A bolt fixed near the top of the link (5) becomes embedded in the concrete.

The panels comprise a steel-channel frame on both faces of which plywood is attached. The panels fit between the soldiers, which are at 4 ft. 6 in. centres, and are clamped in position by a short length of angle extending across the outer face of a soldier and overlapping the panels on either side. The angle is held against the soldier by wing-bolts screwed into a plate behind the flanges of the channels of the soldiers.

When it is necessary to lift the shuttering, the bolt through link (4) and the panel clamps are removed and the tie-

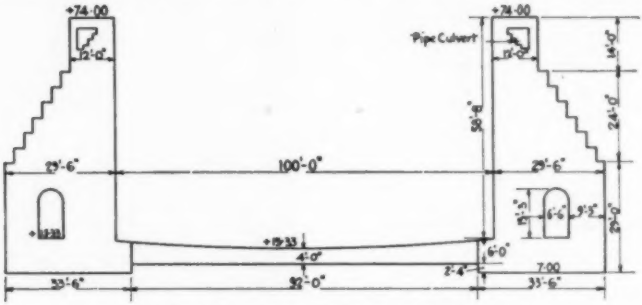

Fig. 3.—Cross Section of Lock.

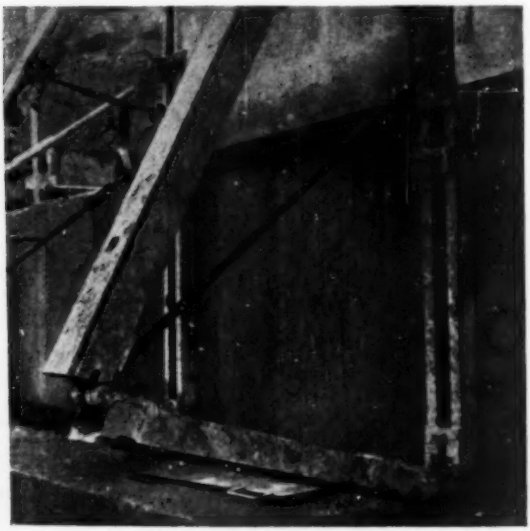

Fig. 4.—Shuttering for Main Wall.

rods released. Rotation about the hinges between links (4) and (5) and links (1) and (5) permits the soldier to take up the position shown by broken lines in *Fig.* 6 without disturbing link (5), that is (4) goes to (4a), (1) to (1a), (2) to (2a), and (3) to (3a), the soldier being held in position by the bolt through link (5). Link (1a) is held in position by fixing the tie-rods. The panels have vertical lugs at each corner which engage pins on the soldiers, so that each panel can be rotated about its upper lugs into position in the lift above, where it is secured by clamps as before. This process of removal and re-erection in one operation is repeated for subsequent lifts.

Concrete.

The mixture of the concrete in the hearting of the walls is generally 405 lb. of cement, 13½ cu. ft. of sand, and 27 cu. ft. of 1½-in. to ⅜-in. gravel aggregate, and in the facing of the dock wall and culverts 608 lb. of cement, 13½ cu. ft. of sand, and 27 cu. ft. of coarse aggregate. Sliding plates are used to separate concretes of the two mixtures. The concrete, of which there will be 340,000 cu. yd. in the walls and of which over 100,000 cu. yd. have been placed, is mixed at a central batching and mixing plant where there

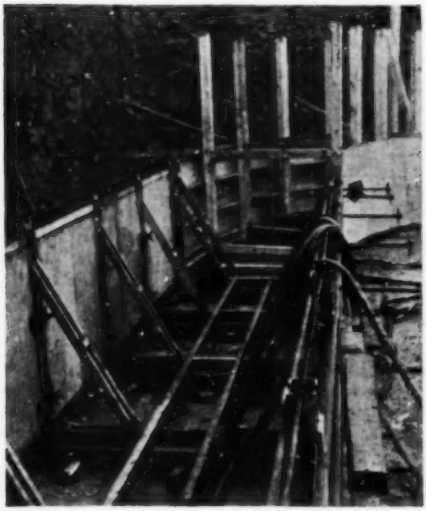

Fig. 5.—Shuttering for Walls of Culvert.

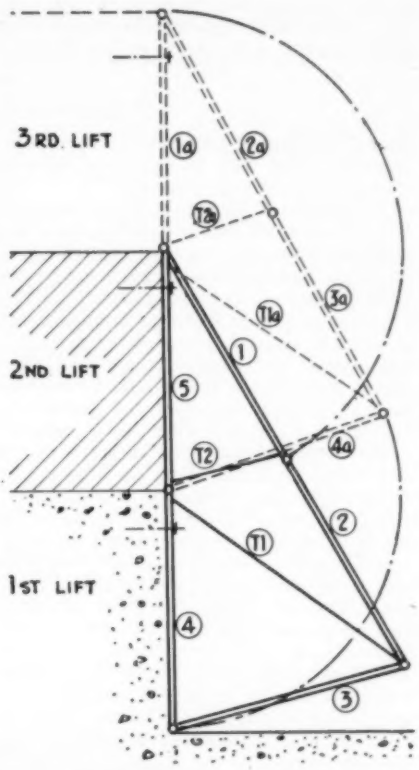

Fig. 6.—Diagram of Climbing Shutters.

are two 2 cu. yd. mixers, and is distributed by 6-in. pumps. The cement is delivered loose in lorries which discharge into the boot of an elevator which takes it to a steel bin. The maximum output of concrete to date is 4000 cu. yd. per week. The walls are concreted for the entire width in 4-ft. lifts vertically (as described) and, in the case of the lock walls, in lengths of 65 ft. with gaps 5 ft. wide between each length; the gaps are filled later. In the leading wall the length concreted at one time is 45 ft. with 5-ft. gaps. Keyed horizontal joints between successive lifts are formed by pressing an open frame into the wet concrete and digging out the concrete within the frame.

Construction commenced in October 1949 and is expected to be completed in

1953. The cost will be about £5,500,000. The engineering staff of the Manchester Ship Canal Company are responsible for the design. The main civil engineering contractors are Sir Alfred McAlpine & Sons, Ltd.

Ready-mixed Concrete.

THE following is an abstract of a note received from the Ministry of Works. Crown copyright is reserved.

Experience with ready-mixed concrete is not very extensive in Great Britain but there are at least five producing firms, and a British Standard Specification for ready-mixed concrete is being prepared. The Ministry of Works has recently asked for the views of producers and users on the advantages and disadvantages of ready-mixed compared with site-mixed concrete, and the following notes are based on information given in over sixty replies.*

Ready-mixed concrete is prepared to any desired specification. It is generally agreed that the product is of higher and more uniform quality than is normally attained by site-mixing, except on large works where similar equipment is installed and control is good. Producers usually guarantee the quality of their product, and users confirm that the guaranteed standard is well maintained. Ready-mixed concrete gives scope for a considerable saving of labour on the site, and if the concrete is discharged directly into the work labour for spreading can also be reduced.

Ready-mixed concrete offers many advantages on congested sites and is particularly valuable for maintenance work and alterations in factories where the occupation of floor space can cause serious production delays. By its use it is possible to escape some of the difficulties of concreting in winter, and to avoid many of the delays to which site mixing is subject in adverse weather.

When using ready-mixed concrete it is important to plan the progress of work carefully. Delay in discharging trucks increases the cost, and if too slow a delivery rate is arranged placing may be delayed. The concrete is usually delivered in loads of 2 to 3 cu. yd., and the whole load must be placed promptly or there may be a risk of premature setting. It may be difficult to maintain scheduled deliveries in congested areas. A difficulty is sometimes found on small works in ensuring that the last load is delivered in time to complete spreading before the normal finishing hour. Delivery trucks require a firm road to the discharge point. If access is poor it may not be possible to discharge directly into the work, and extra handling and spreading costs will reduce the advantage of the material.

The quality of ready-mixed concrete is generally high but its reliability could be affected by inaccurate control of the mixing water during transit. This, however, should not happen with experienced lorry drivers. There is also a risk of ready-mixed concrete being harmed on the site by the addition of water to make it more workable ; the concrete should be placed as soon as it is delivered without altering its condition in any way.

Opinions do not differ greatly on technical matters, but there is less general agreement about cost due to the number of factors involved, and a basis for comparison is difficult to define. The cost of site-mixed concrete varies with the quantity required, weather conditions, and organisation, while the cost of ready-mixed concrete depends greatly on the distance travelled and the extent to which the material can be discharged into position from the lorry. On the basis of opinions considered, ready-mixed concrete is likely to be dearer on many works, estimates of the difference varying from 5*s*. to 8*s*. a cubic yard, but the advantages of using it can offset its actual cost. In the case of small quantities required intermittently within ten miles of a loading station it is cheaper.

Views given to the Ministry indicate that builders are likely to find it worth while to use ready-mixed concrete in the following circumstances: (1) If it is essential to save time and arrangements can be made for rapid placing. (2) Where the site is congested, or if occupation of floor space may delay other important work. (3) When it is important to avoid delays due to adverse weather conditions. The distance should generally be less than twenty miles, but in some cases longer distances can usefully be considered.

* We are informed that the following notes are based on the experience of users and that the claims of suppliers have been included only where they are supported by the experience of users.—Ed.

Transporting and Storing Loose Cement.

THE transport of loose cement as an alternative to the cement being packed in paper bags is now receiving increasing attention due to the high cost of paper bags. A great advantage of the paper bag is that it is a measure of weight of cement, and if a specification requires cement to be measured by weight it may sometimes be more economical for a contractor to pay for the bags than to install storage and weighing plant and employ the extra labour necessary. In Great Britain the cost of cement delivered loose is about 17*s*. 3*d*. per ton less than if delivered in paper bags. A convenient way of measuring loose cement by volume from a site-silo consists of two sliding gates holding a known volume of cement between them, working in a rectangular extension fitted to the bottom of the silo. For measuring by weight the cement may be poured from the silo into a weighing-hopper on rails which is pushed on the rails and emptied into the mixer-skip. In semi-automatic methods the weighing hopper is filled from the silo until the correct weight is reached, when, by a series of links, the balance-arm closes the silo valve; the hopper is then emptied into the mixer by means of a handle.

Messrs. E. Plassmann, E. Ruhland, and O. Färber, of Dyckerhoff Portland Cement Works, Germany, expressed the opinion in an article in "Zement-Kalk-Gips" in 1949 that paper bags are, and will remain, the best means of packing and transporting cement and that but for the present scarcity and high cost of paper there would be no need to consider other methods. Some parts of the following are abstracted from this article which has since been published with additions as a booklet.*

Rail Transport.

Covered goods wagons are commonly employed for carrying loose cement. Before a wagon is put to this use the floor and walls should be tested for tightness, and open joints covered or stopped. Door openings may be blocked by stacking filled cement bags across them so as to procure an enclosed space into which loose cement may be discharged by means of a movable steel pipe or flexible rubber hose. A suitable method of conveying cement from storage bins to the wagon is illustrated in *Fig.* 1, where (a) is a worm conveyor from the storage bins, (b) is an automatic gauge box, (c) a measuring hopper, (d) an automatic outlet valve for determining the volume from the number of revolutions multiplied by the volume of the valve, (e) a conveyor belt, (f) an automatic weighing machine with a cut-off for predetermined quantities, and (g) a weigh-bridge to determine the weight of empty and laden wagons; alternatively a weighing machine may be installed on the

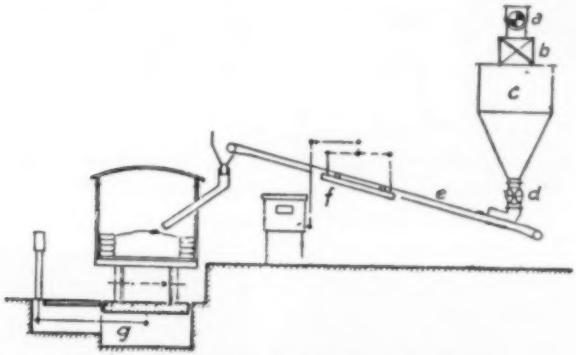

Fig. 1.—Delivering to Railway Wagons.

* "Packen, Verladen, und Transport von Zement." By E. Plassmann, E. Ruhland, and O. Färber. (Weisbaden: Bauverlag G.M.B.H. 1949. Price 2 D.M.)

conveyor belt. In the case of small quantities only one of the measuring devices shown in *Fig.* 1 may be necessary.

To empty the wagon, the doors are opened and a sufficient number of bags removed to provide a working space from which the loose material can be discharged by hand, by power shovel, or by a cement pump. When unloaded by hand the cement may be shovelled from the wagon on to a portable conveyor which takes it to storage or to another vehicle, or it may be shovelled directly into a bin erected beside the wagon and the top of which is below the level of the floor of the wagon, or it may be shovelled into the boot of a bucket-elevator which takes it to an elevated storage bin. When a cement pump is used the wagon may be emptied by a mechanical shovel into the hopper of the pump (*Fig.* 2), or a portable pump may be placed inside the wagon (*Fig.* 3).

An open goods wagon is suitable only for short distances and during fine weather, when the cement can be sufficiently protected against atmospheric influences by the provision of a suitable covering. Special container wagons are available, the vertical hopper-type being particularly suitable. A wagon with two containers of a combined capacity of 26 tons is shown in *Figs.* 4 and 5, where, in the former, the inlets are shown at (a), the connections for the emptying pipes at (b), and the connections for the cement pump at (c). The openings are secured against wind and rain by tight-fitting covers. The cement is pumped through delivery pipes of 4 in. to 6 in. diameter connected to the outlets, and conveyed through pipes to storage bins which may be at a horizontal distance of up to 165 ft. and a height of up to 33 ft. above rail level. Compressed air introduced into the hopper through the connections provided for this purpose loosens the cement. Air collects at the top of the container and its pressure forces the cement through the pipe into the storage bins. The bin is fitted with a filter hose or flue, so as to allow the escape of any surplus air that may collect in the interior of the bin. The advantages of this method are its simplicity, the absence of dust, and the fact that no manual labour is required.

A 2-axle flat-bottomed wagon carrying a container of 24 tons capacity is illustrated in *Fig.* 6, and a container of 38

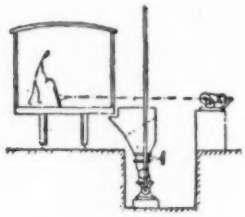

Fig. 2.—Emptying Wagon by Shovel.

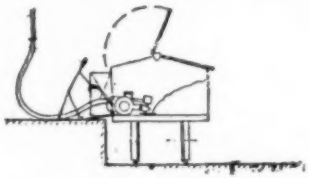

Fig. 3.—Emptying Wagon by Pump.

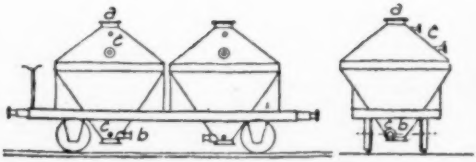

Fig. 4.—Containers for Rail Transport.

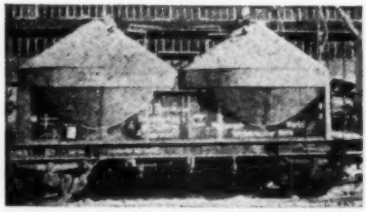

Fig. 5.—Containers for Rail Transport.

to 45 tons capacity on a 2-bogie truck is shown in *Fig.* 7. The container in *Fig.* 6 has at (a) large openings at the top and ends suitable also for bulky goods, (b) a manhole for granular material, and (c) an outlet for granular material. The container shown in *Fig.* 7 has at (a) additional inlet openings and at (b) additional outlet openings. Compared with the hopper-type container, the disadvantage of the boiler-type tank is that compressed air cannot be used when emptying it. The contents of the tank are loosened and stirred by rodding, causing the cement to move towards the outlets at the bottom. To dispose of any residue in the container, men clean it out by hand with shovels.

Although a lorry is the most useful form of transport, as it takes the cement on to the site, rail transport is much more economical. E. Plassmann describes a method (*Fig.* 8) in use in Switzerland. Metal containers of 8 cwt. capacity are mechanically filled and loaded on to a flat wagon. There are 48 containers on each wagon and it takes not more than 15 minutes to load a truck. Unloading and emptying of the containers is also done mechanically, and the containers may also be carried by lorries.

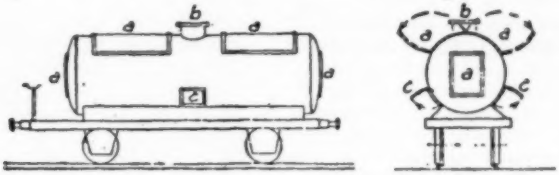

Fig. 6.—Large Container for Rail Transport.

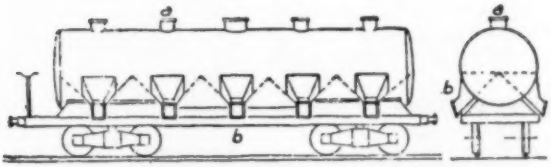

Fig. 7.—Large Container for Rail Transport.

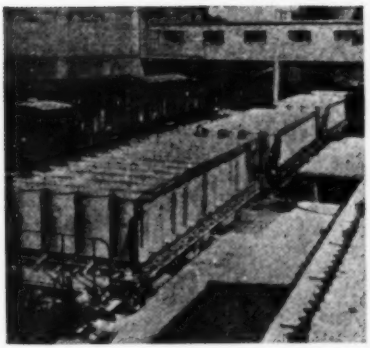

Fig. 8.—Cement Containers in Switzerland.

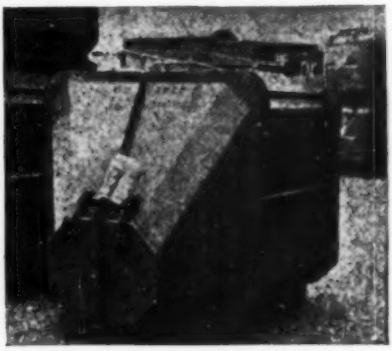

Fig. 9.—Cement Container in France.

Fig. 9 shows a container used in France having a capacity of 4 tons. It is filled at the top and is emptied by tipping the container towards the side with the flap. This container is carried by the French railways at a reduced rate.

Transport by Road.

Loose cement may be transported in flat-bottomed open lorrries. During transport the vibration of the vehicle causes compaction of the cement, with the result that losses due to wind are very slight, amounting to no more than about 1 per cent. The lorry can be provided with a covering. Unless the lorry is of the tipping type, an inclined chute is necessary to unload the cement. Closed containers mounted on the lorries are more efficient. Containers in use with capacities of about 1 cwt. and 2 cwt. are shown in *Fig.* 10. They may be provided with loose covers, or lids fitted with locking devices. The use of an automatic weighing machine is particularly suitable to ensure that the containers receive accurate quantities. Containers of 1 to 2 tons capacity are shown in *Fig.* 11.

Special lorries with vertical hoppers, similar to those for railway wagons illustrated in *Fig.* 4, are also useful. A supply of compressed air required for emptying the tank is obtained from a compressor coupled to the engine of the vehicle.

A further development is the use of horizontal barrel containers on flat-bottomed lorries. A container of this

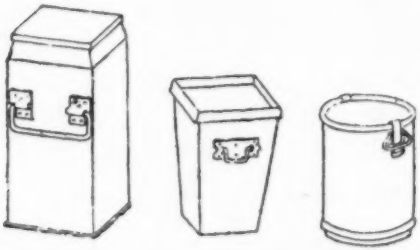

Fig. 10.—Containers for Road Transport.

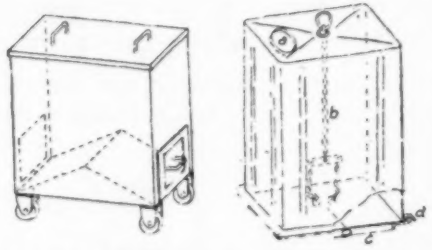

Fig. 11.—Containers for Road Transport.

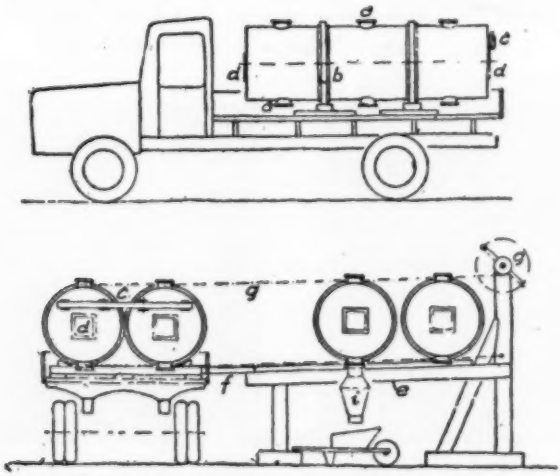

Fig. 12.—Barrel Containers for Road Transport.

type is shown in *Fig.* 12, where (a) are the inlet and outlet openings, (b) the barrel hoops, (c) the coupling bar and locking device, and (d) lateral openings. The method of unloading the containers is shown in *Fig.* 12, where (e) is the unloading platform, (f) a guide rail, (g) a

Fig. 13.—Cement Containers for Short Journeys.

in position during transport, and large openings at the sides enable them to be cleaned by scraping.

In "Zement-Kalk-Gips" for June, 1951, E. Plassmann states an important factor in the transport of loose cement by road is the length of the haul. For short journeys special lorries are satisfactory, but as the lorries cannot take a return load they are uneconomical for long journeys. *Fig.* 13 shows a lorry developed by Messrs. Dyckerhoff for short journeys. It has two containers which are filled with cement and compressed air admitted at the cement works and which are emptied into a site-silo by a connecting hose.

For long journeys ordinary lorries are

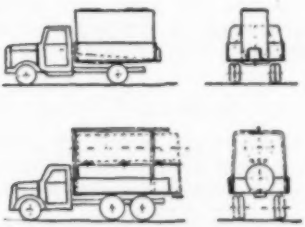

Fig. 14.—Lorries for Long Journeys.

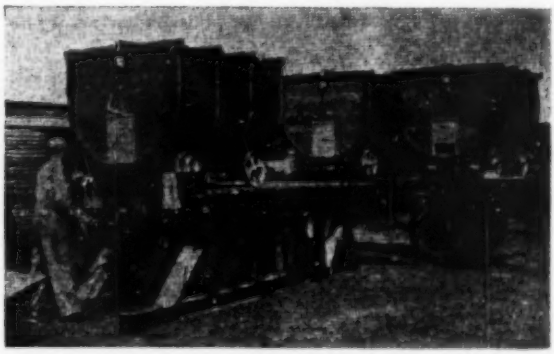

Fig. 15.—Containers for Road Transport.

winding rope and a winch, and (i) a measuring gauge. The light steel containers are rolled off the lorry by means of the rope and winch on to the platform. The capacity of each container is from 2½ tons to 3 tons. Special coupling bars and locking devices are provided at the sides of the lorries to secure the containers most economical. The cement may be carried in large containers, which can be stacked together when empty. Alternatively a single large container is so fitted to the lorry that, when empty, it may be jacked up above the body of the lorry (*Fig.* 14); the raised position of the cement container is indicated by broken

lines. In the case of long journeys the aim must be to provide for return loads.

Two methods for the transport and site-storing of loose cement have been developed by the firm Gebr. Selz and are described in "Betonstein-Zeiting" for June, 1951. In one method metal containers of 3 tons capacity are filled at the cement works, placed on lorry-trailers, and taken to the site. The containers (*Fig.* 15) are mounted on wheels, and by means of a hand-winch are pulled from the trailer on to a tilting bench. *Fig.* 17 shows the bench tilted and the cement being taken from the container. When they are empty the containers are returned to the works for refilling.

In the second method the loose cement is brought in tank lorries and transferred by compressed air into a timber silo on the site (*Fig.* 16).

Other Methods of Transport.

It is reported that about 70 per cent. of the cement produced in Western Germany is transported loose, and in the

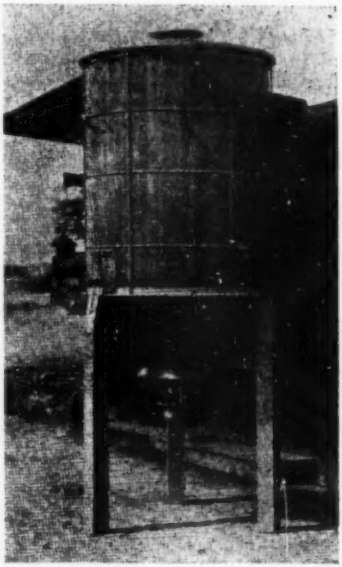

Fig. 16.—Site Silo for Cement.

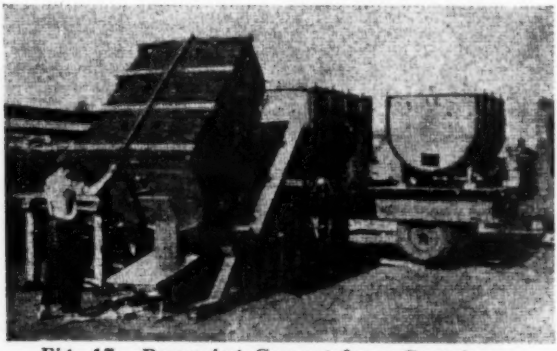

Fig. 17.—Removing Cement from Container.

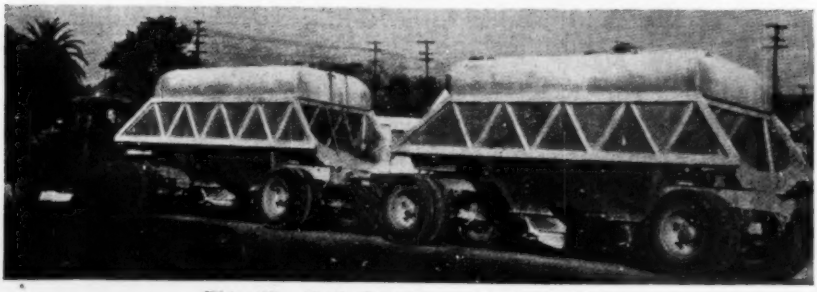

Fig. 18.—Rail Containers in the U.S.A.

United States about 40 per cent. *Fig.* 18 (from "Rock Products") shows aluminium bottom-discharge trailers used in the United States. The tractor and trailer weigh about 11 tons unladen and carry about 25 tons of cement.

A Swedish steamship of 1,600 tons has been converted for the purpose of carrying loose cement. The ship can be loaded by one man in six hours and discharged by two men in twelve hours.

The cement for two dams in Italy was transported in cylindrical galvanised steel

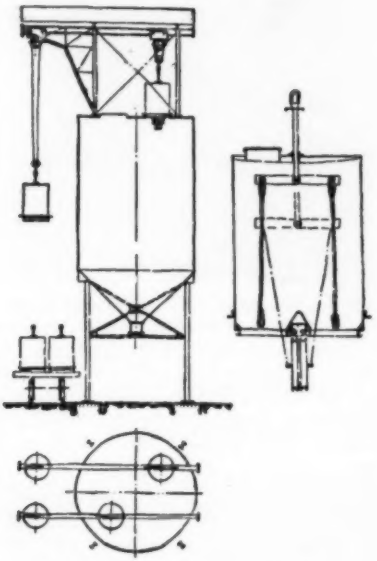

Fig. 19.—A Transfer-Silo.

containers each containing 8 cwt. The containers were filled automatically at the cement works, loaded on to motor-driven trailers, and taken to the railway by which they are conveyed on wagons to the station nearest to the site where they were again loaded on to trailers. The containers were transferred from one vehicle to another on roller conveyors. At the site the cement was discharged from the containers into a small bin from which it was pumped to a 2000-tons silo at the concrete plant. About 200 tons of cement were delivered daily, 12 wagons and 920 containers being used.

Transfer-Silos.

Some German firms have developed methods, also described by E. Plassmann, of delivering loose cement over long and short distances. In each case loose cement is delivered to a transfer-silo by rail or sea, and is then distributed by special lorries to nearby sites. The silos are carefully sited in large cement-consuming areas, and smaller consumers may be served by packing the cement into metal or light-weight-paper con-

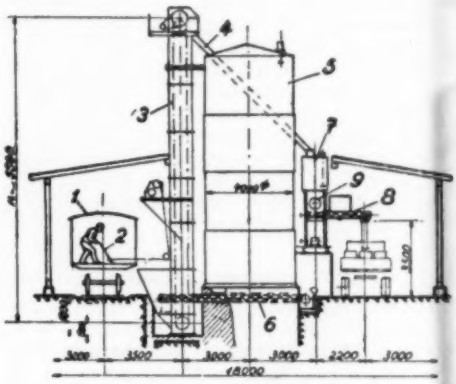

Fig. 20.—A Transfer-Silo.

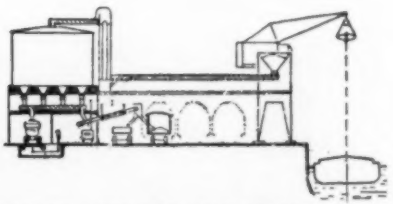

Fig. 21.—Transferring Loose Cement from Ship to Transfer-Silo.

tainers at the silos. *Fig.* 19 shows the method of hoisting and emptying 1-ton rail containers into a transfer-silo built by Messrs. Ruthof in Regensberg. A similar transfer-silo, built by Messrs. Held in Mannheim, is shown in *Fig.* 20. The cement is brought in railway wagons (1) and emptied by a power shovel (2) into a bucket elevator (3). The cement passes down a chute (4) into the transfer-silo (5), or may be diverted into a measur-

ing silo (7). From the measuring silo the cement passes over a weighing machine (8) into lorries. A separate conveyor (6) takes the cement from the transfer-silo to the measuring-silo. *Fig.* 21 shows an arrangement, built by Messrs. Dyckerhoff at Frankfurt, for transferring loose cement from ship to lorry.

Containers for British Railways.

One thousand steel containers of the type shown in *Fig.* 22 have been ordered by British Railways for conveying cement and other granular and powdered materials. The container, which has a capacity of 4 tons of cement, is in the form of a lidded box divided into two equal compartments which can be discharged simultaneously or separately through bottom doors which are opened by the release of a catch. The container is provided with cleats on the sides so that sheets may be fixed during unloading to prevent dust arising.

A Yorkshire Installation.

The method of dealing with loose cement shown in *Figs.* 23 and 24 has been adopted by Messrs. F. Shepherd & Son, Ltd., contractors, of York, for works of small and medium size, and it is stated that a suitable cement silo of about 8 tons capacity can be provided for £60.

Fig. 22.—Container for British Railways, with One Bottom Door Open.

The specially-designed lorry carries two pressure-containers, each with a capacity of 3½ tons of loose cement and designed for a working pressure of 40 lb.

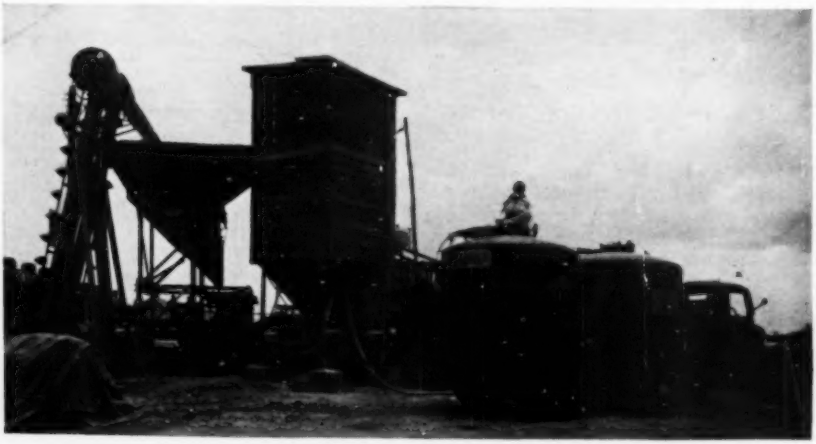

Fig. 23.—Containers and Silo for Loose Cement in Yorkshire.

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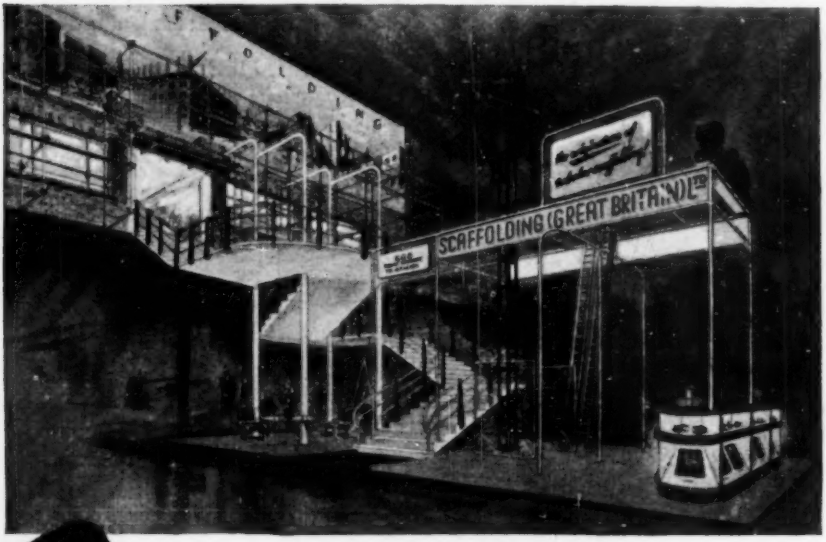

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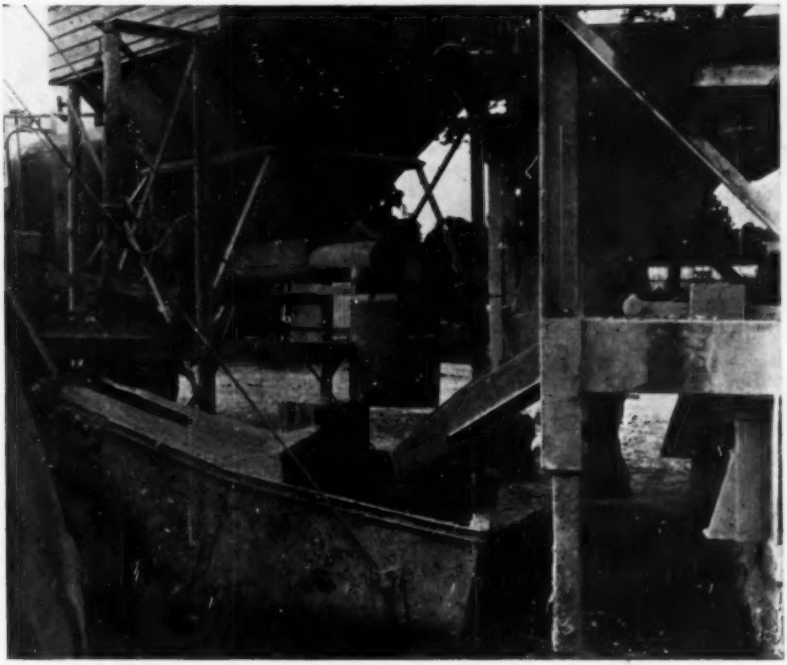

Fig. 24.—Discharge from Aggregate and Cement Silos Shown in Fig. 23.

per square inch. The air-compressor is driven by the engine. This equipment was designed by a firm of engineers at Bradford who had been associated with the development of a vehicle for handling pulverised-coal by compressed air in the year 1937; it is also similar to vehicles which have been used by a Swedish cement manufacturer during the past two years.

The silo shown in the illustrations was supplied by a Swedish firm, and is equipped with an electrically-driven screw-conveyor for extracting the cement and an automatic scale for measuring the cement from the silo to a tipping-bucket on a swinging arm. The cement is filled into the silos by compressed air, which escapes through a cloth filter at the top of the silo. The owners inform us that the plant has been in operation for three months and has proved to be satisfactory, and that they expect to recover the cost of the vehicle and silo in less than one year. At present the vehicle is used for transporting cement up to forty miles from the cement works. A larger silo is being built in York from which cement can be taken for local delivery at times when the demand exceeds the capacity of the vehicle to fetch cement from the cement works.

A British Standard for Excavators.

A NEW British Standard, No. 1761 (1951) (price 6*s*. from the British Standards Institution), deals with single-bucket excavators up to 2½ cu. yd. capacity mounted on tracks and with all motions friction driven. Face shovels, drag-lines, drag-shovels, skimmers, grabbing cranes, cranes, and pile drivers are described and illustrated, and data are given on factors of safety, stability, controls, power units, electrical equipment, and testing.

Cleaning and Sealing Joints in Concrete Roads.

DEMONSTRATIONS of the use of machines for cleaning joints in concrete roads and of a method of refilling the joint were given recently on the Kingston by-pass by the Road Research Laboratory. The process is first to pass a machine along the joint to plane the top of the old filler and a strip of the surface of the road on both sides of the joint; this is not always required. Another type of cutter is then fitted and the joint traversed again; this cuts out the old filler to a depth of about 1 in. and reshapes the arrises of the concrete slab. Another machine is then passed along the joint and brushes out the debris left by the preceding operation and cleans the faces of the joint. A third machine removes any dust remaining in the joint and applies a bitumen primer. The joint is then filled with a substance which may be poured in hot. The machines are pushed by hand at walking pace.

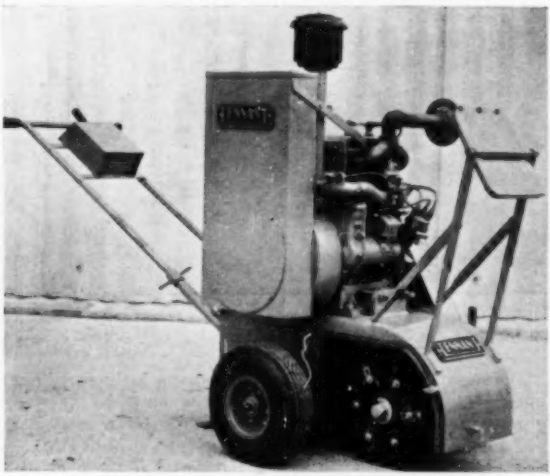

Fig. 1.—Cutting Machine.

The cutting machine (*Fig.* 1) is principally a rotary cutting tool driven by a 13·3-h.p. petrol engine. The cutting tool comprises two disks mounted on a shaft which rotates at 2400 r.p.m., and six cutters fitting loosely on bolts between the disks. Due to the rotation of the disks the cutters attack the filler and the sides of the joint with a flail-like action. By means of spacers the cutters are in different vertical planes, and because of their loose fitting they can tilt slightly and so trim a rounded or chamfered arris. The spacing of the cutters can be varied so that grooves from $\frac{3}{8}$ in. to $2\frac{1}{4}$ in. wide can be cut. The depth of the cut can be varied by adjusting the level of the shaft.

The disks and cutters can be replaced by other disks between which are several finer and smaller cutters loosely mounted on each bolt. This tool is used for planing the top of the filler and the concrete before the main cutting operation.

The correct alignment during travel is obtained by registering with the joint the image, seen in a mirror, of a small pin projecting from the front of the machine. The machine weighs about 6 cwt.

The cleaning machine (*Fig.* 2) comprises principally a rotating wire-brush wheel on a shaft driven at high speed by a petrol engine. It is used for removing

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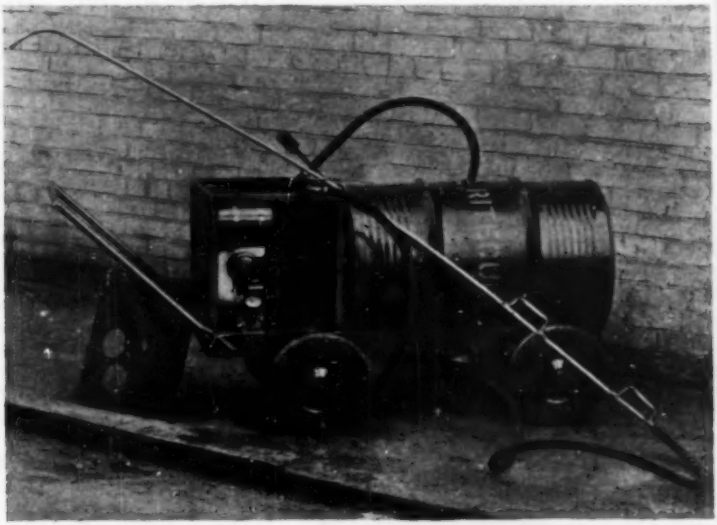

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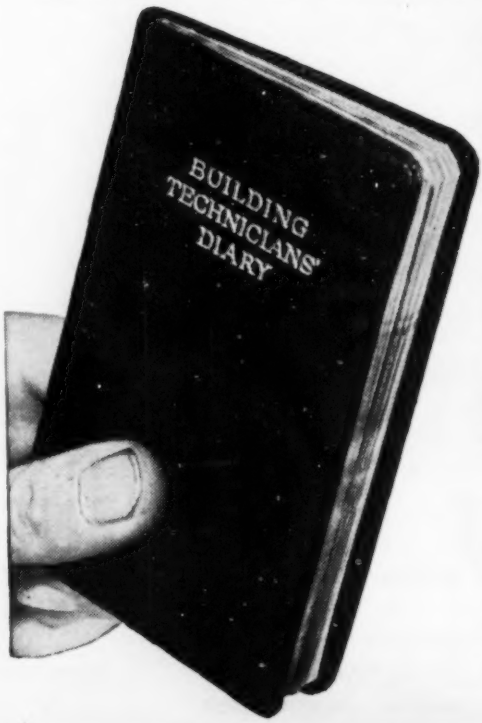

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dust and laitance from joints of new roads and, after the passage of the cutting machine, for cleaning out old joints. It works less well if much bituminous filler is left on the sides of an old joint. It cleans out grooves up to 1 in. deep, and if the groove is wide two brushes can be fitted on the same shaft.

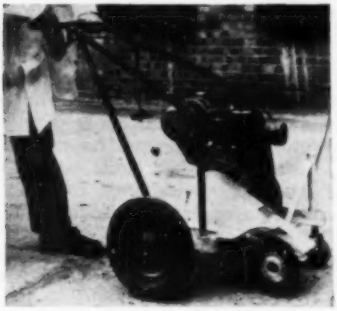

Fig. 2.—Cleaning Machine.

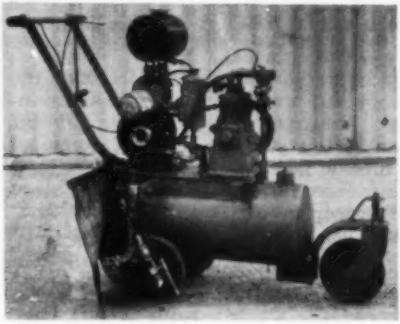

Fig. 3.—Priming Machine.

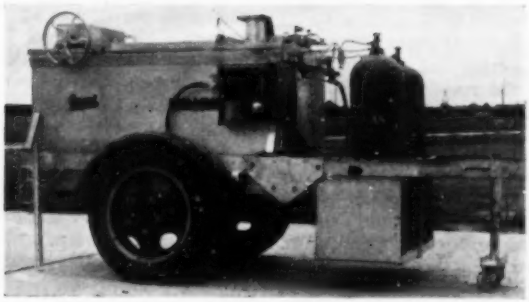

Fig. 4.—Heater.

The priming machine (*Fig.* 3) comprises an air-compressor driven by a petrol-oil engine, a tank containing the bituminous primer, and two jets; from the forward jet air is played into the joint to remove dust, and from the second the primer is sprayed into the joint. Both actions operate simultaneously. The thickness of the coating of primer is determined by the speed at which the machine is pushed.

If the filler is to be applied hot a heater is required. The type used in the demonstration (*Fig.* 4) is a steel tank containing a rubber-bitumen compound melted by incandescent gases passing through tubes across and along the tank and surrounded by the compound. The temperature is thermostatically controlled, and was 150 deg. C. for the compound used; the range is from 40 deg. C. to 320 deg. C. A hand-operated stirrer keeps the molten compound in motion. The gas is contained in cylinders carried on the chassis of the machine, which is moved by towing. The molten compound is discharged from a tap at the back of the tank into cans or buckets from which it is poured by hand into the grooves of the joints after the primer has been applied.

The illustrations were supplied by the Road Research Laboratory. The cutting machine is made by the G. H. Tennant Co., of Minneapolis, U.S.A. The cleaning machine is supplied by Expandite, Ltd.,

for use with fillers supplied by this firm. The priming machine is a white-line marking machine adapted as a spraying machine and is supplied by Tarpen Engineering Co., Ltd., of London. The heating machine is supplied by Aeriol Products Co., Inc., Hackensack, N.J., U.S.A.

Book Reviews.

"Beton-Kalender, 1951." Two volumes. 40th edition. (Berlin: Wilhelm Ernst & Sohn. 1951. Price 16 D.M.)

THE new edition of this handbook on the theory and practice of concrete and reinforced concrete is again in its pre-war form of two volumes, which are revised to include new developments. The first volume contains sections on mathematics, the properties and testing of structural materials, theory of structures, design of reinforced concrete, and the German regulations. The second volume deals with estimating and construction, foundations, retaining walls, walls of buildings, floors, roofs, precast concrete, girder bridges (with notes on prestressing), rigid-frame and arch bridges, scaffolding, silos, and the regulations of other countries.

The main departure from previous editions is the simplified calculations for the design of reinforced concrete in accordance with the recommendations of a German committee. Bending combined with direct force is considered to be the general case, from which the condition of bending only follows as a particular case. The sizes of members are established to satisfy constructional needs, and the amount of reinforcement required is then calculated. Little importance is attached to the exact calculation of the maximum stresses in the concrete in the orthodox manner, as it is considered unnecessary so long as the stresses are reasonably within permissible limits. Some of the cumbersome stress equations, notably those for tee-beams, are omitted and others are given in an appendix for engineers who wish to use the common method of design.

"Beton und Zement im Seewasser." By A. Eckhardt and P. W. Kronsbein. (Berlin: Wilhelm Ernst & Sohn. 1950. Price 6.50 DM.)

THIS short report of the behaviour of concrete in sea-water is based on tests made at Wilhelmshaven Marine Research Station on specimens of 1 : 3, 1 : 4 and 1 : 5 concrete using different types of cement. The 1 : 3 concrete only was satisfactory, and cubes stored in sea-water for thirteen years showed that only those made with high-alumina cement were completely satisfactory. The conclusions are briefly that concrete in sea-water must be dense and have at least 680 lb. of cement per cubic yard. The water content should not exceed the amount required for maximum density, and the concrete should be placed in the dry, or, where placing under water is unavoidable, a tremie should be used. Construction using large concrete blocks is very satisfactory. Rounded gravel aggregate is preferable. The compressive strength of the cement is not so important as its rapid-hardening properties and resistance to chemical attack. Cements deficient in lime are recommended, and the addition of trass, without reducing the quantity of cement, is advisable.

"Bindemittel für Massenbeton." By K. Walz. (Berlin: Wilhelm Ernst & Sohn. 1951. Price 5.50 DM.)

IN this report, by a German committee, investigations on hydraulic binding agents are described. Favourable results of the use of binding agents composed of a mixture of cement, lime, and trass for mass concrete in underwater work 30 to 40 years ago led to tests from 1941 onwards on prisms 4 cm. square and 16 cm. high placed for 5½ years alternately in air and half submerged in a sodium-sulphate solution. Specimens mixed in the proportions of 35 per cent. of Portland cement, 10 per cent. of lime, and 55 per cent. of trass showed the greatest resistance to chemical attack. Specimens made of cement and trass showed some signs of deterioration, and those of cement only disintegrated completely. The report comprises 47 pages of typescript and is illustrated by tables, diagrams, and photographs.

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(*Continued on page* lx.)

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(*Continued from page* lix.)

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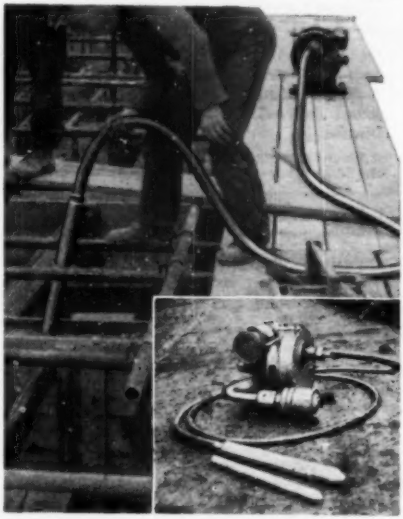
HIS MAJESTY'S COLONIAL SERVICE.—Applications are invited for the following post: ASSISTANT MATERIALS ENGINEER (27322/229), KENYA, PUBLIC WORKS DEPARTMENT. Candidates, who should be under 40 years of age, should hold a university degree in engineering or the A.M.I.C.E. and have at least five years' experience in civil engineering works, of which preferably not less than a year should have been spent on materials testing and control, which should include soils, concrete, bitumen, etc. Appointment will be on two years' probation for permanent and pensionable employment in a salary scale £655 to £1,320 per annum. The point of entry into the scale, determined by age and approved experience, is likely to be in the region of £900 for a suitable candidate. Local Government superannuation rights can be preserved. Income tax is at a low rate. A generous cost-of-living allowance is at present payable. Free passages are provided for the officer and his wife, and for children up to the cost of one adult passage, on appointment and leave, which is granted on full salary at the rate of 4½ days per month of service. An officer provided with furnished quarters pays a rent of ten per cent. of his salary. When quarters are not available an allowance is payable. On first appointment a married officer will not be allowed to take his wife and family to Kenya until he has secured accommodation for them. Intending candidates should apply in writing to the DIRECTOR OF RECRUITMENT (COLONIAL SERVICE), Colonial Office, Sanctuary Buildings, Great Smith Street, S.W.1, giving brief details of their age, qualifications, and experience. They should mention this paper and quote the reference number (27322/229).

(*Continued on p.* 349.)



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MISCELLANEOUS ADVERTISEMENTS.

(*Continued from p.* lx.)

SITUATIONS VACANT. Imperial Chemical Industries, Ltd., Wilton Works, near Redcar, have vacancies for civil engineering draughtsmen. Applicants should have had experience of drainage works, water distribution systems, and road works. A knowledge of surveying is desirable. Application forms may be obtained from the STAFF OFFICER, IMPERIAL CHEMICAL INDUSTRIES, LTD., Wilton Works, P.O. Box 54, Middlesbrough, Yorkshire, quoting advertisement reference ICI/X/91/m.

SITUATIONS VACANT. Imperial Chemical Industries, Ltd., Wilton Works, near Redcar, have vacancies for structural designers and detailers to be engaged on steel and reinforced concrete structures, foundations, industrial buildings, etc. Good working conditions include 5 day/39 hours' week and superannuation scheme. Applications quoting advertisement reference no. ICI/X/74/v. should be addressed to the STAFF OFFICER, IMPERIAL CHEMICAL INDUSTRIES, LTD., Wilton Works, P.O. Box 54, Middlesbrough, Yorkshire.

WANTED.

WANTED. 8 tons of 1-in. mild steel reinforcing rods. Other diameters offered in exchange. RIBAR, LTD., Higher Swan Lane, Bolton, Lancs.

FOR SALE.

FOR SALE. Sacks, bags, and curing cloths for sale. You want the best type and quickest delivery. Write JOHN BRAYDON, LTD., 26 The Highway, London, E.1. Telephone: ROYal 1044.

Prestressed Concrete.

A BROCHURE entitled "Prestressed Concrete Manual," in which the Magnel-Blaton system is described and illustrated, is available from Stressed Concrete Design, Ltd., 54 South Side, London, S.W.4.

REQUIRED. One or two firms of repute wishing to enter into arrangement or agreement on a suitable or royalty basis for the manufacture, production, and sale of a well-known precast concrete floor and roofing product now being used in various parts of the country. Also contract for the supply and erection as desired. Areas available: London, Home Counties, South, East and West Counties of England, Southern Wales, and Scotland. Further particulars can be obtained on application by bona-fide and reputable firms. BOX 2509, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

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DORMAN LONG

Apparatus for Testing the Hardness of Concrete.

IN "Beton-und Stahlbetonbau" for February, 1951, W. Neuffer describes an apparatus developed in Switzerland for testing the hardness of concrete. The apparatus (*Fig.* 1) consists of a steel tube containing a spring which can be released by a finger trigger. The end of the tube is placed against the concrete to be tested and, on releasing the spring, a small steel hammer impinges against the concrete.

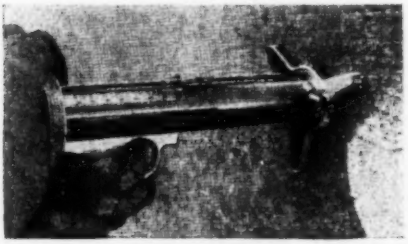

Fig. 1.—Hammer for Testing New Concrete.

The hammer then rebounds until it is brought to rest by the resistance of the spring. The position at which the hammer stops is indicated by a gauge and pointer on the steel tube. The amount by which the spring is compressed is an indication of the hardness of the concrete and is called "hardness factor". The mean of six to ten readings spread over an area 4 in. to 8 in. square free of shutter marks and honeycombing is taken.

A comparison with crushing tests shows that it is not possible to obtain exact values. It is, however, possible to obtain quickly a guide to the strength of the concrete so that the quality of the concrete may be checked from day to day.

DATA FOR PRICING REINFORCED CONCRETE.

Materials.

(*Delivered in London area.*)

AGGREGATES (per cu. yd.).—Washed sand, 20*s.* Clean shingle: ¾ in., 17*s.*; ½ in., 19*s.* 6*d.* Thames ballast, 18*s.* 9*d.*

CEMENT (per ton, delivered at Charing Cross).—Portland cement, 6 tons and upwards, 95*s.* 3*d.* 1 ton to 6 tons, 100*s.* 3*d.* Paper bags and non-returnable jute sacks included. Rapid-hardening Portland, 8*s.* above ordinary Portland. Aquacrete and 417, 32*s.* 6*d.* above ordinary Portland; paper bags included. Colorcrete (buff, red, and khaki), in 6-ton loads, 136*s.* 9*d.*; paper bags included. Snowcrete, £12 12*s.* 9*d.*, inc. paper bags. "Super-Cement," 32*s.* 6*d.* per ton above ordinary Portland cement; paper bags included. High-alumina cement, 1 ton and upwards, 255*s.* per ton; paper bags 22*s.* per ton extra. Snowcem paint, 71*s.* per cwt. inc. containers.

SHUTTERING.—For prices of timber, refer to S.R. & O., 1949, No. 1079 (price 1*s.* 1*d.*) and No. 94 (price 5*d.*) issued by H.M. Stationery Office.

REINFORCEMENT.—Mild steel round bars (per cwt.); ¾ in. to 2¾ in., 35*s.* ⅜ in. to ½ in., 36*s.* ⅝ in., 37*s.* ½ in., 39*s.*

Materials and Labour.

(*Contracts up to £5000. Inc.* 10 *per cent. profit.*)

PORTLAND CEMENT CONCRETE, 1 : 2 : 4.—Foundations, 3*s.* 8*d.* per cu. ft. Columns, 3*s.* per cu. ft. Beams, 3*s.* per cu. ft. Floor slabs 4 in. thick, 9*s.* per sq. yd.; Do., 5 in., 11*s.* 3*d.*; Do., 6 in., 13*s.* 6*d.*; Do., 7 in., 15*s.* 9*d.* Walls 6 in. thick, 13*s.* 6*d.* per sq. yd. Add for hoisting 3*s.* 6*d.* per cu. yd. above ground floor level. Add for rapid-hardening Portland cement 2*s.* per cu. yd.

REINFORCEMENT.—Mild steel round bars, including cutting, bending, fixing, and wire (per cwt.)—¼ in. to ⅝ in., 56*s.* ⅜ in. to ½ in., 50*s.* ⅝ in. to 2¾ in., 47*s.*

SHUTTERING AND SUPPORTS.—Walls, 175*s.* per square. Floors (average 10 ft. high), 180*s.* per square. In small quantities, 2*s.* 3*d.* per sq. ft. Columns, average 18 in. by 18 in. (per sq. ft.), 2*s.* 3*d.*; in narrow widths, 2*s.* 4*d.* Beam sides and soffits, average 9 in. by 12 in. (per sq. ft.), 2*s.* 4*d.*; in narrow widths, 2*s.* 5*d.* Raking, cutting, and waste, 6*d.* per lin. ft. Labour on splays, 3*d.* per lin. ft. Small fillets to form chamfers, 6*d.* per lin. ft.

Wages.

The rates of wages on which the above prices are based are: Carpenters and joiners, 3*s.* 3*d.* per hour (carpenters 2*d.* a day tool money); Labourers, 2*s.* 9½*d.*; Men on mixers and hoists, 2*s.* 11½*d.*; Bar-benders, 3*s.*

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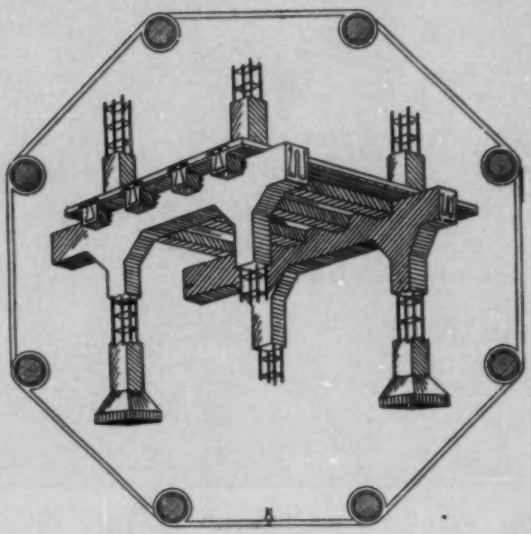

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